GAUGING UNMASKED,

WHICH SHEWS ALL

THE NECESSARY RULES

IN

VULGAR AND DECIMAL ARITHMETIC,

WITH SEVERAL

CONTRACTIONS IN BOTH.

The Extraction of the Square and Cube Roots.
STEREOMETRY, or the whole ART of GAUGING, by the Pen and Sliding Rule; with the Forms and Definitions.
The method of keeping the STOCK-BOOK for ALE and X WATERS.
Tables of CYLINDERS and AREAS of CIRCLES and SQUARES.

THE WHOLE DESIGNED

FOR THE USE AND SERVICE OF THE

REVENUE OFFICERS,

Being calculated according to (217.6) the Solid Inches contained in the LIQUID GALLON, now used in

IRELAND.

BY JOHN BALLARD, EXCISE OFFICER.

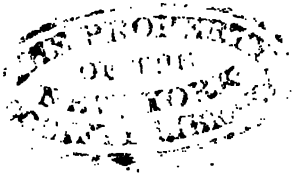
——— *Si quid novisti rectius istis,*
Candidus imperti : Si non his utere mecum.
Horat. Lib. 1. Epist.

Printed and published by Order of the Right Honourable and Honourable the Chief Commissioners and Governors of His Majesty's Revenue of Ireland.

Cork:

Printed by EDWARDS & SAVAGE, Booksellers and Stationers, No. 6, Castle-street.

1812.



To the Right Hon. and Hon. the

CHIEF COMMISSIONERS AND GOVERNORS

OF

HIS MAJESTY'S REVENUE IN IRELAND.

May it pleaſe your Honours.

I HAVE at my leiſure hours penned a Treatiſe, entituled, GAUGING UNMASKED; in which I have endeavoured to diſperſe the clouds which overſhadow thoſe great truths in *Euclid*, *Tacquet*, and other obſcure, though learned writers. It is a received truth, and confeſſed by all who have a true taſte to the elegancy and ſurpriſing beauty of Numbers, that they are now, and always will be, capable of new diſcoveries: for moſt writers, in taking upon them to explain thoſe profound Problems, do inſenſibly hurry the confuſed reader into a labyrinth, and that by a chain of dark and perplexed terms, as the great POPE has it, in his *Eſſay upon Criticism*:

Some loſe their ſenſe their learning to display,
And ſome explain the meaning quite away.

For my part I beg leave to aſſure your Honours, that I have uſed all my induſtry to make thoſe great men ſpeak for the advantage of the public, and that in plain and intelligible terms; and as this Treatiſe is intended for the improvement of the REVENUE OFFICERS, my duty directed, and your Honours ſtation challenged this dedication. To mention here your Honours great abilities for this large truſt, or your impartial management of affairs, I ſay, though ſhining characters, and perſpicuous in your Honours, yet they are already too well known to the public, to admit of any improvement by any panegyric of mine; the intereſt of the Revenue, your Honours have always made and eſteemed your own; and I hope this work, which is conduſive to that ſame intereſt, ſo far as the reformation of its Officers, will meet encouragement from your Honours. The activity of a crowned head is read in his ſoldiers; juſt ſo, the judgment of Governors, in that of their Officers: *Notus in Fratres animo Paterno*, was the great commendation which HORACE gave one of his Patrons. It is certain, whoever goes about to reform ſuch as count themſelves his equal in place, undertakes an office beſet with difficulties;

it ſpeaks a confidence of his own capacity, and at the ſame time ſeems to infer a charge of ignorance upon others: and as every man has a conceit of his own merit, he thinks himſelf undervalued by inſtruction: it is but an unacceptable civility, to offer to let in the rays of underſtanding upon thoſe minds, which are uſed to ſubſiſt in the dark; it is like opening day light upon a neſt of Owls, which always ſets them a ſcreeching. But neither thoſe, nor any other diſcouragement, (but your Honours denying me a protection) ſhall hinder me from the generous attempt of endeavouring to be uſeful in my ſtation: though I am ſufficiently ſenſible of the greatneſs of the deſign, and have long wiſhed that ſome abler genius would have undertaken it. With this reſolution I humbly conclude,

May it pleaſe your Honours,

Your moſt dutiful,

Moſt humble, and

Moſt obedient ſervant,

JOHN BALLARD.

To the Reader.

Honeſt Reader, for to ſuch I ſpeak,

IT is as ſtrange to meet a Book without a Preface, as to meet a Lady paying a viſit without tedious compliments and ceremony, in which (like your fulſome Prefaces) they take up more time than in the viſit itſelf; but in my judgment, a piece well done, needs none, and what is ill done I am ſure deſerves none: As to my part, I have no deſign to argue my reader into a complaiſance to this my Work, by a ſtudied Preface, nor can I apprehend a neceſſity of courting a reception, where the Work, carries along with it the force of demonſtration. This ſhort Tract was principally deſigned for the uſe of the REVENUE OFFICERS, but may indifferently ſerve others; and as a neceſſary preparative to Stereometry, (which is the burthen of this Treatiſe) I have prefixed the common Rules of Vulgar and Decimal Arithmetick, but after an uncommon method; with ſeveral uſeful Tables; and the method of extracting the Square and Cube Root. And then I preſume, that I have made the Art of Gauging conſpicuous to all ſuch as have not ſhook hands with their reaſon, and that by the Pen, and inſtrument called the Sliding Rule: I have likewiſe calculated and brought Mr. EDGAR's Table of Cylinders, from 35 to 45 Inches Diameter, with many other varieties, better known by the Table of Contents, in the front of this Work. Yet if after all my care to be plain, correct, and uſeful, ſome Perſon (of more ill-nature than perhaps judgment) ſhall ſay, truly he does not like this Work; to him I anſwer, it is much eaſier not to like, than to do the like. And ſo conclude, (impartial Reader)

Your very humble Servant,

JOHN BALLARD.

Longford,
January 22d, 1733.

RECEIPTS

For making BLACK and RED INK.

FOR BLACK INK.

TAKE three Pints of Rain or River Water, in a Quart of which you muſt infuſe three Ounces of ſound Galls, pounded fine; letting them ſteep for ten days in an earthen veſſel, often ſtirring them: Alſo you muſt infuſe in the other Pint of Water, two Ounces of Gum Arabic; and at the expiration of ten days, you muſt ſtrain the Liquor from the Galls, and therewith mix your Gum Water, putting thereto one Ounce of Copperas, and a ſmall Quantity of double-refined Sugar; then boil the whole gently over a ſlow Fire and ſo bottle for uſe.

FOR RED INK.

TAKE a Pint of Strong Beer, an Ounce of raſped Braſil-wood, half an Ounce of Roch Alum, a penny worth of Cochineal, boil the Beer and Braſil only, and that over a ſlow Fire, till half is conſumed; then ſtrain it, mixing therewith the other ingredients; all which you muſt then boil moderately over a Fire, till it comes to a true colour, thereto putting about half an Ounce of Gum Arabic; and then it is fit for uſe.

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Mathematical

Mathematical Notes or Abbreviations: *all which should be carefully observed, and rightly underſtood as they frequently occur in the following Work.*

= The Note for Equality; ſo A=B ſignifies that A and B are equal.

+ The Note for Addition; ſo A+B ſignifies the Sum of A and B added together.

— The Note for Subtraction; ſo A—B ſignifies the difference between A and B.

× The Note for Multiplication; ſo A×B ſignifies A multiplied by B.

: The Note for Equality of Proportion; ſo A : B :: a : b ſignifies that A bears the ſame proportion to B, that a bears to b.

q The Note for a Square; ſo C B q ſignifies the Square of the line C B.

c The Note for a Cube; ſo C B c ſignifies the Cube of the line C B.

VULGAR ARITHMETICK.

ARITHMETICK

Is an Art or Science that teaches us the dextrous handling of Numbers.

NUMERATION.

THE way of numbering among the Antients, was by the Letters of their reſpective Alphabets; for Example, with the *Romans*, C, ſignifies 100, D, 500, M, 1000, &c.

So among the *Grecians*, A, ſignifies 1, B, 2, T, 3, I, 10, P, 100, &c.

But note, that the moſt common way of expreſſing the value of Numbers, is by the *Arabick* Notes or Characters, by them called *Ziphers*, by the *Hebrews Sephers*, and by us *Cyphers*; and they are ten, *viz.* 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, and, as *Gemma Friſius* obſerves, we place thoſe characters from the right-hand to the left; from the Hebrews.

The TABLE.

C. of Millions.	X. of Millions.	Millions.	C. of Thouſands.	X. of Thouſ.	Thouſ.	Hundreds.	Tens.	Units.
								1
						3	2	1
					4	3	2	1
				5	4	3	2	1
			6	5	4	3	2	1
		7	6	5	4	3	2	1
	8	7	6	5	4	3	2	1
9	8	7	6	5	4	3	2	1

You ſee in the oppoſite Table, how each place exceeds the former Ten Times; increaſing in Value towards the left hand.

Observe the following method of numbering.

This was the way of Numbering among the *Romans*.

XX	is	20
XXX		30
XL		40
L		50
LX		60
LXX		70
LXXX		80
XC		90
C		100
CC		200
D		500
DC		600
M		1000

This Book was wrote in the Year of our Lord MDCCXXXIII. Or, 1733. By *J. B.*

ADDITION.

ADDITION is the gathering of divers Numbers into one total Sum. *See Hill*, page 13.

N.B. You must place Units under Units, Tens under Tens, &c. and for every Ten carry One to the next place.

Example.

Integers, *viz.*

45364
21578
63459
130401

Integers.

78345629
6421843
562462
45631
3428
613
78
3
85379687

So much for Integers.

Of

Of divers Denominations, as of *Money, Weight, Measure,* &c.

Of Money.

For every 4 Farthings carry one Penny; for 12 Pence one Shilling; and for 20 Shillings one Pound.

L.	*s.*	*d.*
567	13	$3\frac{1}{2}$
418	18	$4\frac{1}{2}$
546	13	$8\frac{3}{4}$
1533	5	$4\frac{3}{4}$

Another Example with the Proof of Addition.

Add your Numbers downward, contrary to the common way, carrying as usually, and if the Total be the same both ways, you are right, *viz.*

	433	17	$6\frac{1}{2}$
	764	19	$4\frac{1}{4}$
	285	18	$8\frac{3}{4}$
Ergo the Sum is	1474	15	$7\frac{1}{2}$
Proof	1474	15	$7\frac{1}{2}$

N.B. $\frac{1}{4}$ is one Farthing, or a Quarter of any thing.

$\frac{1}{2}$ is one Half-penny, or 2 Quarters of any thing.

$\frac{3}{4}$ is three Farthings, or 3 Quarters of any thing.

SUBTRACTION.

BY Subtraction we find the difference of any two Numbers, by taking the leſſer from the greater; whereby the difference will appear.

Take care to place Units under Units, &c. and in caſe of want in ſubtracting borrow 10, and for every 10 ſo borrowed, pay one in the next place.

I bought 96783 bundles of Yarn, of which I have ſold 47894 bundles; what remains to be ſold?

	96783
	47894
To be ſold	48889

Subtraction in Money.

In this, you muſt in caſe of want in the Farthings, borrow 4, or 1 Penny, and in the Pence borrow 12, or 1 Shilling, and in

the Shillings borrow 20, or 1 Pound, remembering always to pay what you borrowed to the next place, by calling the lower Figure one more than it is.

I lent	743	13	5¾
Received	454	15	6¼
Unpaid	288	17	11½

A Second way of Subtraction.

I think it a much better way, when any thing is borrowed, to add to the Figure in the number from whence you ſubtract, in caſe it's too little, to take what is borrowed from the Figure ſtanding next towards the left hand of the Figure that is too little, and ſuppoſe the Figure from whence you borrow to be ſo much leſs; ſo will you never need to pay what was borrowed, as before taught.

Here, inſtead of ſaying 4 from 11 reſts 7, and 1 borrowed and 8 is 9 from 12 reſts 3,—it will be much leſs trouble to ſuppoſe the Ten borrowed, to be actually taken from the 2 as it really is; and ſo the reſt of the Figures:———So muſt you ſay, 4 from 11 reſts 7,—8 from 11 reſts 3,—1 from 8 reſts 7,—9 from 17 reſts 8,—and 2 from 2 reſts 0,—this way of Subtraction is much more natural and reaſonable than the common way; and I dare engage it would be found much better.

Example.

From	37921	
Take	29184	Add
	8737	
Proof	37921	

In *Troy-Weight*, *Avoirdupois*, &c. you muſt ſubtract as uſual, ſtill remembering whether you are numbering *Money*, *Weight*, *Meaſure*, or what.

To prove Subtraction, add the ſum to be ſubtracted to the remainder, as in the foregoing example, and the total will be equal to the number from which you ſubtract, if your work be right.

The Author hereof was born in the Year One Thouſand Seven Hundred, and he wants to know how old he is in the Year 1733?

1700

Anſwer 33

There

There was a Bond perfected in the Year of our Lord 1685, how many Years Interest is due in the Year 1733 ?

1685

Answer 48

What Number of Pounds, Shillings, and Pence added to 34*l.* 16*s.* $9\frac{1}{4}d.$ will make 100*l*?

	34	16	$9\frac{1}{4}$	} Add
Answer	65	3	$2\frac{3}{4}$	}
£.	100	0	0	Proof.

MULTIPLICATION.

BY it we increase one Number by another, as oft as there are Units in either, and is very necessary in Arithmetick ; a Thousand Questions being resolved thereby ; it consists of three Members, *viz.*

The *Multiplicand*, or Number to be multiplied.

The *Multiplier*, or number by which we multiply.

The *Product*, or the Number arising or produced from both.

But before we proceed, observe the Table.

1	2	3	4	5	6	7	8	9	12
2	4	6	8	10	12	14	16	18	24
3	6	9	12	15	18	21	24	27	36
4	8	12	16	20	24	28	32	36	48
5	10	15	20	25	30	35	40	45	60
6	12	18	24	30	36	42	48	54	72
7	14	21	28	35	42	49	56	63	84
8	16	24	32	40	48	56	64	72	96
9	18	27	36	45	54	63	72	81	108
12	24	36	48	60	72	84	96	108	144

In

In *Multiplication* it holds, as an Unit to the Multiplier, so is the *Multiplicand*, to the Product; this Product in Geometry, is called the Rectangle.

N.B. In this Rule, when working, for every Ten, you must carry One to the next Place.

If one Yard cost 5 Shillings, what will 64 Yards cost? Here one Yard bears such proportion to 5 Shillings, as 64 Yards will bear to the Product.

To work this Question, place your Numbers in order as below.

	yd.	s.	yds.	
If	1.	5.	64	Multiplicand.
			5.	Multiplier.
Product			320	Shillings, or 16 Pounds.

Multiply 1728
By 7

12096 Product.

This Question is the same as if one had demanded, 1728 Weeks how many Days?

Other Examples.

(1.)

	3421
	36
	20526
	10263
Product	123156

(2.)

	462725
	2007
	3239075
	925450
	928689075

(3.)

	46725
	2400
	18690000
	93450
	112140000

(4.)

	123456
	1000
	123456000

In my (2d) Example, I contracted my Work by omitting the Cyphers, only keeping their Places vacant.

In

In my (3d) Example, I multiplied by 24, adding two Cyphers to the Product.

In my (4th) Example, I added three Cyphers to the Multiplier, for one neither multiplies nor divides, and ſo of any other ——And as it neither multiplies nor divides, by ſome it is ſaid to be no Number; but 1 and 1 being two, prove the contrary.

Another way of Multiplication without any charge to the memory, and that by ſetting down the whole Product of the Multiplication of every ſingle figure, whereby the carriage of the Tens will be ſaved; but the trouble of Addition will be the greater.

Example.

See the Work.

Firſt, 9 times Five is 45, which ſet down,—then 9 times 1 is 9, which ſet down under the 4 and a Cypher before the 4.—and 9 times 2 is 18, place 8 under the 0 and 1 before it, —and 9 times 4 is 36, place 6 under the 1 and 3 before it,—next 7 times 5 is 35, which place under 89.—and 7 times 1 is 7, which place under 3 and a 0 before it,—and 7 times 2 is 14, place 4 under 0 and 1 before it,—and 7 times 4 is 28, place the 8 under 1 and 2 before it,—laſtly, 8 times 5 is 40, which place under 47,—and 8 times 1 is 8, which place under 4 and a 0 before it,—and 8 times 2 is 16, place 6 under 0 and 1 before it,—and 8 times 4 is 32, place 2 under 1 and 3 before it, and the Work is done.	Multiply by	4215 879 31045 689 21035 847 31040 268 3704985

N. B. That in this way of working, when the Product of any Figure will not make 10, you muſt place a Cypher where the Figure which when above 10 is to ſtand, as in the above Work; and this one Example is ſufficient to ſhew the Learner how this Work may be performed.

DIVISION.

DIVISION is in effect the deducting of a leſs Number, as oft as may be, out of a greater, and in it you muſt note three Parts, *viz.*

1ſt, The *Dividend*, or Number to be divided.

2d, The *Diviſor*, or Number by which you divide.

3d, The *Quotient*, or Number proceeding from both; and oft a 4th Number, called a remainder.

Here, as the Diviſor to an Unit, ſo the Dividend to the Quotient.

So if 4 Yards coſt 32 Shillings, what will one Yard coſt?

Here 4 Yards, the Diviſor, bears ſuch proportion to an Unit or one Yard, as 32 Yards, the Dividend, doth bear to the Quotient; and will be an Anſwer to the Queſtion.

To work this Queſtion, place your Numbers thus, *viz.*

	yds.	s.	yd.
	If 4.	32.	1. *facit* 8 ſhill.
		1	
Becauſe 1 doth not multiply, I divide 32 by 4, ſaying, How oft 4 in 32? Anſwer, 8 times; which I place in the Quotient, as you ſee.	4)	32	(8 ſhill.
		32	
		0	

The Demonſtration of Diviſion.

The deſign of Diviſion is to diſcover how oft the Diviſor is contained in the Dividend; whence it neceſſarily follows, that the Quotient contains 1 or Unity, ſo often as the Dividend contains the Diviſor; and if the Quotient contains Unity as often as the Dividend does the Diviſor, it follows from the 5th Definition of the 5th Book of *Euclid*'s Elements, that the Quotient is in proportion to 1, as the Dividend is to the Diviſor: and conſequently by the 16th of the 16th of *Euclid*'s Elements, the Product of a true Quotient, multiplied by the Diviſor, is equal to that of Unity by the Dividend; and all Quotients anſwering thus are true, and otherways not.

Example.

If 144 be divided by 6, the Quotient ariſing (by the foregoing Rules for Diviſion) will be 24.

For

For the Quotient 24 contains 1 ſo often, as 144 contains 6, and conſequently by the definition above,

24 : 1 :: 144 : 6

That is, as 24 is in proportion to 1, ſo is 144 to 6.

And by the ſaid 16th of the 6th of *Euclid*,

24×6 :: 144×1

That is the Rectangle or Product of the two extremes, 24 by 6, is equal to that of the 2d mean or middle number, 144 by 1, ſo that 24 is the true Quotient of 144 by 6.

The reſult of this Arithmetical Diviſion is the ſame with the Geometrical, and is demonſtrated by *Euclid* 44, 1.

Diviſion is either Single or Double.

Single Diviſion is when the Diviſor is but one Figure, and the Dividend but two at the moſt; as in the firſt Queſtion; and that may be performed by the memory, or otherways by the Table of Multiplication; thus, find your Diviſor on the top of the Table, running down the ſame till you find the Dividend, and over againſt it you have in the firſt column the Quotient ſought, *viz.* under 4 and oppoſite 32 you have 8 in the Table.

Another way of Diviſion.

Obſerve diligently, that Diviſion may be performed without any charge to the memory, and that by making a Tariffa or Tablet of your Diviſor, multiplied into the 9 Digits; and will prove of excellent uſe, eſpecially in great numbers. And by a little practice you will come to the full knowledge of Diviſion, and conſequently enabled to work freely without the help of any ſuch Table.

Example.

See the Table.

Let the Dividend be 67254, and the Diviſor 19, make a Table by Duplication, or Addition, or Multiplication.

Oppoſite to 1 in your Table, place your Diviſor, *viz.* 19 for 2, double your Diviſor or firſt Number, as 38; for 3, add the firſt and ſecond Number, as 57, for 4, double the ſecond Number, as 76, for 5, add the Sum of the 2d, and 3d, as 95, for 6, double the 3d Number, as, 114, for 7, add the Sum of the 3d and 4th, as 133, for 8, double the 4th, as, 152, for 9, add the Sum of the 4th and 5th Number, as 171, as in the Table.

1	19
2	38
3	57
4	76
5	95
6	114
7	133
8	152
9	171

Or you may make this Table otherways; for Example, Multiply your Diviſor (19) by any of the nine Digits, and it will anſwer as in the Table, as thus, 19 multiplyed by 7, is 133.

See the Work.

To work the former Queſtion, place your Numbers as uſual, then ſee how far your Diviſor will reach into your Dividend, which will be two Figures, which is 67, well, how oft 19 in 67; look in your Table for that Number which comes nearest to 67, and you'll find it to be 57; and you'll find that 57 oppoſite the Digit 3, which ſhews you that 19 can be had 3 times in 67; place your 3 in the Quotient, and your 57 under 67, then ſubtract and it leaves 10, to which bring down 2; then ſay, how oft 19 in 102? look in your Table for the next leſs Number to 102, and you will find 95, and that oppoſite to the Digit 5, which ſhews you that 19 may be had 5 times in 102; then work as uſual, and after your ſubtraction you will find left 7, to which bring down 5 from the dividend; and aſk how oft 19 in 75? conſult your Table, and you will find the neareſt Number to 75 is 57, oppoſite the Digit 3, which 3 place in your Quotient, and work as uſual; and after your ſubtraction you will find 18, to which bring down the laſt Figure, *viz.* 4, then aſk, how oft 19 in 184? your table tells you 9 times, becauſe oppoſite the Digit 9 you find 171, which is next leſs to 184, and when ſubtracted leaves 13 for a Remainder; and thus your work is finiſhed, and your Quotient is $3539\frac{13}{19}$

```
19)67254(3539 13/19
  ....
  57
 ----
  102
  95
 ----
   75
   57
 ----
  184
  171
 ----
   13 remain.
```

A Third way of Diviſion.

Here I ſhall annex two or three contractions in Diviſion, by ſhewing how you may divide by any of the 9 Digits, without ſetting down any Figures but the Quotient itſelf; provided the Number be contained in the Multiplication-table.

1ſt Example.

To divide by 2, is to halve the Number, ſetting down the Figures of the Quotient orderly under the Dividend; ſo in the Example, the $\frac{1}{2}$ of 7 is 3, which place in your Quotient, and carry the 1 that remains, which will make 16; then the $\frac{1}{2}$

Divi. 7642 *by* 2

Quot. 3821

of

of 16 is 8, which place in your Quotient; then take the $\frac{1}{4}$ of 4, which is 2, and that place in your Quotient; laſtly, take the $\frac{1}{2}$ of 2, and that is 1, which place in your Quotient, and it will be 3821, as above.

2d *Example.*

To divide by 3 is to take $\frac{1}{3}$ of the Number given; ſo $\frac{1}{3}$ of 7 is 2, and 1 carried to the 4 is 14, and $\frac{1}{3}$ of 14 is 4, and 2 carried to the 2 is 22, the $\frac{1}{3}$ of 22 is 7, and the 1 carried to the 6 is 16, the $\frac{1}{3}$ of 16 is 5, and 1 remains, which is $\frac{1}{3}$, and the Quotient is $2475\frac{1}{3}$.

Divide	7426 by 3
Quot.	$2475\frac{1}{3}$

3d *Example.*

To divide by 5 is to take $\frac{1}{5}$ of the Number given; ſo here, $\frac{1}{5}$ of 6 is 1, which ſet down, and 1 carried to the 7 makes 17, and $\frac{1}{5}$ of 17 is 3, which ſet down and 2 carried to the 4 makes 24, the $\frac{1}{5}$ of 24 is 4, which ſet down, and the 4 carriage brought to 5, makes 45, and the $\frac{1}{5}$ of 45 is 9, which ſet down, and the Quotient is 1349; and ſo of any other.

Divide	6745 by 5
Quot.	1349

The way to prove Diviſion.

Multiplication and Diviſion mutually prove each other; for in Multiplication, if you divide your Product by your Multiplier, the Quotient will be your Multiplicand; likewiſe, in Diviſion if you multiply your Quotient by your Diviſor, that Product will be your Dividend.

Example.

7) 12096 (1728

	7	7
Tutiſſimum eſt, ut per invicem hæ ſpecies examinentur, cum reliquæ praxes ſint errori obnoxiæ Vid. Tacq. lib. 1. cap. 11.	50	12096 the proof of Diviſion.
	49	
	19	
	14	
	56	
	56	
	0	

Queſtion.

If a C. of Tobacco, or 112lb. coſt 2*l.* 11*s.* 4*d.* what will one Pound weight coſt?

See the Work.

2. 11. 4.
20

51
12

First, I brought 2*l.* 11*s.* 4*d.* into Pence, and divided by 112, gives 5*d.* in the Quotient; the Remainder multiplied by 4, for Farthings, and that divided by 112, gives two Farthings.

112)616(5 Pence.
560

56
4

112)224(2 Farthings.
224

0

REDUCTION.

BY this we change Money, Weight, Meaſure, &c. and thereby learn how many of one Denomination are equal to ſo many of another.

I will here (though contrary to moſt other Authors) divide Reduction into 3 Parts.

1. Reduction by Multiplication.
2. Reduction by Diviſion.
3. Reduction by Multiplication and Diviſion; and thoſe regularly.

Reduction by Multiplication,

is when we bring a greater Denomination into a leſs, as Pounds into Shillings, Pence into Farthings, Yards into Quarters or Nails, &c.

Queſtion.

Queſt. 1.

See the Work.

Reduce 36*l.* 7*s.* 9*d.* 1*q.* into Farthings. Firſt, I multiplied by 20, and as I multiplied; took in the 7 Shillings; and the Shillings, *viz.* 727, I multiplied by 12, bringing in the 9 Pence; and thoſe Pence, *viz.* 8733, I multiplied by 4, bringing in the 1 Farthing, and the Product is, 34933 Farthings, and the Work is finiſhed.

36*l.* 7*s.* 9*d.* 1*q.*
20
727 Shillings.
12
1463
727
8733 Pence.
4
34933 Farthings.

Reduction by Diviſion.

Reduction by Diviſion is when we bring a leſs Denomination into a greater; as Farthings being divided by 4, give Pence in the Quot.; and Pence divided by 12, give Shillings; and Shillings divided by 20, gives Pounds Sterl.

In this part of the Rule, we will uſe the converſe of the above Queſtion, *viz.*

In 34933 Farthings, how many Pounds, Shillings, Pence, &c.

See the Work.

	12)	20)	*l.* *s.* *d.* *q.*
4) 34933	(8733	(727	(36. 7. 9. 1. which is equal to the
32	84	6	above Sum.
29	33	12	
28	24	12	
13	93	7 Shill.	Obſerve that the Remainder is
12	84		always of the ſame Denomination with the Dividend.
13	9 Pence.		
12			
1 *q.*			

Another way of working this Queſtion.

In 34933 Farthings, how many Pounds, *&c.?*

See the Work.

Inſtead of dividing the Farthings by 4, I took ¼ part of the Farthings, *viz.* 8733, as in the work, and in the ſecond part of the above work; then inſtead of dividing by 12, I took $\frac{1}{12}$, *viz.* 727, to bring them into Shillings, and from the Shillings, I cut off the laſt Figure, and took half the reſt, *viz.* half 72, inſtead of dividing by 20, and the Anſwer is 36*l.* 7*s.* 9*d.* 1*q.*

A Table of the Aliquot Parts of a *Shilling*.

For	*d.*	take		Part.
	1		one 12th	
	1½		one 8	
	2		one 6	
	3		one 4	
	4		one 3	
	6		one ½	

See Ditto Parts of a *Pound*.

For	*s.*	*d.*	take		Part.
	1	0		one 20th	
	1	8		one 12	
	2	0		one 10	
	2	6		one 8	
	3	4		one 6	
	4	0		one 5	
	5	0		one 4	
	6	8		one 3	
	10	0		one ½	

Queſtion 3.

In 71568 Pints, how many Hogſheads? Anſwer, 142 Hogſheads.

See the Work.

71568 Pints
8946 Gall.

I divided the Pints by 8, to bring them into Gallons, and then by 63 to bring them Gallons into Hogſheads. But I have not ſet down the Diviſion by 8, as it was needleſs.

Galls.	Hogſheads.
63) 8946	(142
63	
264	
252	
126	
126	
0	

THE GOLDEN RULE.

THIS Rule is called the Rule of Three, or Rule of Proportion, becauſe there are always Three Numbers given to find a fourth, which muſt bear ſuch proportion to the Third, as the Second doth to the Firſt, and is called the Golden Rule for the excellency thereof; as *Tacq. lib.* 4. *cap.* 1. and of the 3 Numbers given, has always 2 of the ſame Denomination; *viz.* the 1ſt and 3d are always of one Name or Denomination; and alſo the 4th and 2d Number muſt be of one and the ſame Denomination; and as the chiefeſt difficulty lies in ſtating your Queſtion, obſerve this:

Methodus, qua ex tribus numeris datis eruitur quartus proportionalis incognitus, regula proportionum dicitur, ab aliis ob tres numeros datos regula trium, ab aliis aurea, ob ſummam utilitatem appellatur.

The firſt and Third are ſtill the ſame,
The Mid-one has another Name;
And that the Fourth you may not miſs,
The unknown Quant. it always is.

1ſt *Example.*

If 32 Rundlets of Brandy coſt 96 Pounds, what will 4 Rundlets coſt?

Here

Here you ſee the 1ſt and 3d Number are Rundls. the middle is Pounds, and becauſe I wanted the price of 4 Rundlets, I put it in the 3d Place.

If your 4th your 2d muſt exceed.
By the extreme be it multiply'd;
But if leſs than Second do you aim,
To multiply by the leſs extreme.

Rundl.	£.	Rundl.
32.	96.	4.
	4	
32)	384	(12 Anſw.
	64	
	0	Remains.

2d *Example.*

If 13 Packs of Yarn coſt 326 Pounds, what will 39 Packs coſt?

Having ſtated your Queſtion, it may be eaſily ſeen that the Fourth Number will exceed the Second, for 39 Packs muſt needs coſt more than 13 Packs; wherefore I multiply the Second, or middle Number, by the greater of the two Extremes, *viz.* 39; then muſt the other Extreme, *viz.* 13, be my Diviſor.

P.	£.	P.
If 13.	326.	39.
	39	
	2934	
	978	
13)	12714	(978*l.* the
	117	(Anſw.
	101	
	91	
	104	
	104	
	0	

3d *Example.*

If 64 Yards of Broad-Cloth coſt 38*l.* 8*s.* what will 5 Yards coſt?

Becauſe your Numbers muſt be of one Denomination, before you work, reduce 38*l.* 8*s.* into Shillings.

20

768 Shill.

qrs. *s.* *yds.*
If 64 : 768 : : 5
5
64) 3840 (60*s.* or 3*l.* *the Anſ.*
384
00

Here I multiplied the middle Number by the leſs Extream, becauſe the 4th muſt be leſs than the 2d, and the fourth Number muſt be of the ſame Denomination with the ſecond: ſo here your 2d Number being Shillings, your 4th Number or Anſwer is Shillings, *viz.* 60 Shillings or 3 Pounds.

Note. When the firſt Number of the three given is but an Unit, the operation is performed by Multiplication only.

Example.

If I give 15*s.* for a Pound of Thread, what will 250 Pounds coſt?

1lb. : 15*s.* : : 250lb.
15
1250
25

Anſwer, Shillings. 3750 or 187*l.* 10*s.*

Note alſo: When the 3d Number of the three given (or that towards the right-hand) is an Unit ſuch operation is performed by Diviſion only, if the Number needs no reducing.

Example.

If 40 Pieces of Broad-Cloth coſt 590 Pounds Sterling, what will one Piece coſt?

Pieces. *Pounds.* *Piece.*
40 : 590 : : 1
4|0) 59|0 (14¾, or 14*l.* 15*s.* the Anſwer.
19
3 Pounds remains.

If 17 Hogſheads of Sugar coſt 320*l.* 12*s.* what will five Hogſheads coſt?

Hogh. £. *s.* *Hogh.*

17 : 320 12 : : 5

20

6412 Shillings
5 Hogſheads } Multiply

17) 32060 (1885 (94*l.* 5*s.* 10*d.* 2*q.* $\frac{6}{17}$

150 2|0

146 8

0 remains.

100

15 Shillings remain,
12 Pence in a Shilling. } Multiply

30
15

17) 180 (10 Pence,

10 Pence remains,
4 Farthings in a Penny } Multiply

17) 40 (2 Farthings.

6 Farthings to be divided by 17.

Note. That when you have multiplied the ſecond and third Numbers together, and divided the Product by the firſt, the Quotient is of the ſame Denomination as the ſecond Number is, after you have reduced it into its loweſt Denomination given, as in the laſt Example.

And obſerve, that the 6 Farthings which remained in the laſt Example to be divided by the common Diviſor, *viz.* 17, as you can reduce them into no lower a Denomination, you may place them over your Diviſor, as above.

If 20 Men do a Piece of Work in 60 Days, in how many Days will 30 Men do the ſame Work?

This Queſtion is eſteemed by moſt Writers as a Queſtion of the Rule of Three *Inverſe*; but as my Deſign is to inſtruct and not to puzzle the Learner, I ſhall make no needleſs Diſtinctions between it and the Rule of Three *Direct*; the Method herein laid down, being ſufficient to work Queſtions in all Caſes: As here I conſider that the fourth Number ſought will be leſs than the ſecond, becauſe 30 Men will needs require leſs Time than 20 Men; wherefore I multiply the middle Number by the leſs Extream, and divide by the greater, and the Anſwer is 40, as in the Work.

m.	*d.*	*m.*
20	: 60	: : 30
	20	
	30) 1200	(40 Days.
	120	
	00	

And it often happens that you meet a Queſtion of the Rule of Three propoſed, that may require ſome Preparation before you can ſtate your Queſtion, either by Addition, Subſtraction, Multiplication, or Diviſion, as in the following Example. A Merchant at *London* buys 64 Tuns of *French* Wine for 460 Pounds, the Freight thereof from *France* to *London* coſt 220 Pounds, for loading and unloading 10 Pounds, for Cuſtom 15 Pounds, the Charge of a Cellar 8 Pounds, and would gain 250 Pounds by the Bargain.

A Gentleman demands the Price of 24 Tuns of the ſaid Wine, what muſt he give?

By Addition find the total Sum of the Freight, with all the Expences and Gain, which is 963 Pounds.

		Tuns	*£.*	*Tuns*
460	Then ſay, If	64	: 963	: : 24
220			24	
10				
15			3852	
8			1926	
250				
963 Pounds.			64) 23112	(361*l.* 2*s.* 6*d.* Anſw.
			192	
			391	
			384	
			72	
			64	
			$\frac{8}{64}$ or $\frac{1}{8}$	

Proof of the Golden-Rule.

If four Numbers be proportional, the Product of the two Means, is equal to the Product of the two Extreams.

Hence to prove the Work, multiply the 4th Number found, by the firſt Number; and if that Product be equal to the Product of the 2d by the 3d, the Work is right.

So if 8 Yards coſt 16*l.* what will 45 Yards coſt? Anſw. 90*l.*

Yards *£.* *Yards*
8 : 16 : : 45
45
80
64
8) 720 (90
72
00

Then the 4 proportional Numbers will be

8 : 16 : : 45 : 90

45 × 8

80
64

720 the Product of the 1ſt and 4th.

720 the Product of the 2d and 3d.

You ſee the Product of the 1ſt and 4th, is equal to the Product of the 2d and 3d, which ſhews the Work right.

Hence if of four Numbers, the 1ſt be to the 2d as the 3d is to the 4th, thoſe 4 Numbers ſhall be proportional; but if your 3d Number be leſs than the 1ſt and require more; or more, and require leſs; then the Product of your 1ſt and 2d will be equal to the Product of your 3d and 4th.

Example.

If 12 Men do a Piece of Work in 16 Days, in how many Days will 24 Men do the ſame Piece of Work?

Men *Days* *Men*
If 12 : 16 : : 24
12
32
16
24) 192 (8 Days, the Anſwer.
192
0

Then

	m.	d.	m.	d.
Then the 4 Numbers will be	12	: 16 : : 24	:	8
	16		8	
	72		192	
	12			
	192			

Here you may ſee the Product of the 1ſt by the 2d is equal to the Product of the 3d and 4th; which ſhews the Work to be right.

☞ And this is the whole Intrigue of the *Golden-Rule*, or the *Rule of Three*; the which being rightly underſtood, the other Rules of Fellowſhip and Alligation, as likewiſe the Rule of Falſe, will not be at all difficult: And therefore I hold it needleſs to be multiplying Rules and Examples of this ſort; but will immediately proceed to what will be more uſeful to my preſent Purpoſe, *viz. Decimal Arithmetick*, and beſt ſuits my deſigned Brevity.

DECIMAL ARITHMETICK.

DECIMAL ARITHMETICK derives its Name from the very intent or meaning of the Word, as implying the Integer to be divided into ten equal Parts; whether it be Money, Weight, Meaſure, Time, &c.

Note. A Cypher, placed to the left Hand of an Integer, or to the Right of a *Decimal*, neither increaſeth or decreaſeth the Value; but placed to the Right of an Integer, increaſeth the Value; and to the Left Hand of a Decimal, decreaſeth it. *See the Table.*

The

The *Table of Numeration.*

Hundred of Millions.	Tens of Millions.	Millions.	Hundreds of Thousands.	Tens of Thousands.	Thousands.	Hundreds.	Tens.	Unit.	Tenth Parts.	Hundred Parts.	Thousand Parts.	Ten Thousand Parts.	Hundred Thousand Parts.	Millions of Parts.	Ten Millions of Parts.	Hundred Millions of Parts.
9	8	7	6	5	4	3	2	1	.	2	3	4	5	6	7	8	9
Integers									*Decimals.*								

In this Table you may obſerve, that as Integers increaſe in a tenfold Proportion to the Left Hand, ſo Decimals decreaſe in a tenfold Proportion to the Right Hand.

So 5, 50, 500, 5000 } is { Five, Fifty, Five Hundred, Five Thouſ. } { And .5, .05, .005, .0005 } is { 5 Tenth., 5 Hundr., 5 Thouſ., 5 T.Tho. } Parts.

ADDITION OF DECIMALS.

IN Addition of Decimals the operation is the ſame with that in *Vulgar Arithmetick*, care being taken to place all Figures of the ſame Value exactly under each other.

Example 1ſt.

Let it be required to add .8456 Parts to .53
Place your Numbers thus .8456 and not thus .8456
.53 .53

And the Sum will be 1.3756 and not .8509

Note. When you have added your Decimals together, you muſt

muſt prick or cut off as many from the Sum, as are in the greateſt Number in the Decimals given; and the reſt, if any, are Integers, as above.

Example 2d.	*Example 3d.*
.789	.39462
.3642	.0013
.153	.99
.9761	.176
2.2823	1.56192

But if your Numbers given to be added, are not all of the ſame Denomination, they muſt be brought into Fractions of like Denominations, as follows.

Let it be required to add 725 of a Pound, and 625 of a Shilling, into one Sum.

Firſt find what Decimal of a Pound 625 will preſent, which is eaſily done; if you prefix a Cypher, then half the Number is the Decimal of a Pound.

The Number with a Cypher prefixed is .0625, and the half is .03125

Then I add, .725 / .03125 *Sic de cæteris.*

the Sum is 75625

Note, That Addition of Decimals is proved after the ſame manner as that of Vulgar Arithmetick.

SUBTRACTION OF DECIMALS.

SUBTRACTION OF DECIMALS differs little from that of Integers, only as in Addition, keep Units under Units in Integers, and Tenths under Tenths in Decimal Parts.

Example.

Let it be required to ſubtract .728 from .95236 which are to be placed thus:

		L.		*Feet.*	
From	.95236	So if from 36	.86	From 495	.75
Subtr.	.728	you ſubtr. 7	.9845	Subtr. 368	.425
Rem.	.22436	Rem. 28	.8755	Rem. 127	.325

If the decimal Parts in either Number have fewer Places than the other, the vacancy is to be ſupplied by annexing ſo many

many Cyphers as will make them equal, or ſuppoſing them to be annexed, as here,

Cyphers annexed.		*Suppoſed annexed.*	
From	536.4500	From	536.45
Subtr.	239.6925	Take	239.6925
Reſt.	296.7575	The Rem.	296.7575
From	58.00	From	37
Take	27.92	Take	0.104
Reſt.	30.08	Reſt.	36.896

But if your Numbers given to be ſubtracted are not of the ſame Denomination, you muſt (as was told you in Addition) bring them into one Denomination, as in the following Example.

Let it be required to ſubtract .03125 of an ounce Troy, from .0625, of a Pound Troy.

Seeing one is the Decimal of an Ounce, and the other the Decimal of a Pound, bring them both into the Decimal of a Pound, by dividing .03125, the Decimal of an Ounce, by 12, the Ounces in a Pound, and it will give .002604.

.03125 × 12 = .002604

then { From .0625 / Subtr. .002604

pw. gr.

Reſt, .059896=14 8

Or you may bring them both into the Decimal of an Ounce, by multiplying .0625, the Decimal of a Pound, by 12, the Ounces in a Pound, which is the Converſe of the laſt, and it will give .7500 or 75, both being the ſame.

.0625 × 12 = .7500

Then from .75

Subtract .03125

pw. gr.

Reſt .71875=14 8 and ſo of any other.

Note, Subtraction is proved here, as in Vulgar Arithmetick,

MULTIPLICATION OF DECIMALS.

MULTIPLICATION of Decimals is the ſame with Multiplication of whole Numbers, both in the placing and operation, with this reſerve, that when the operation is finiſhed, there muſt be as many Decimals in the Product as there are in both your Multiplier and Multiplicand; and if there be not ſo many, as will ſometimes happen, (as when you multiply two Fractions together that are of little value) then you muſt prefix as many Cyphers to the left hand of your Product as will make them equal.

In Multiplication of Decimals, it is proper to make that Number the Multiplicand which contains moſt Places, though ſometimes it may be leſs in Quantity. And note, That if both Terms to be multiplied be Decimals, the Product will be a Decimal; or if both be mixed, *viz.* if each Term conſiſts of Integers and Decimals, ſo will the Product; but where one is mixed, and the other a Decimal, the Product will ſometimes be mixed, and ſometimes a Decimal.

Example 1ſt.

Multiply	.1264	Multiplicand.
by	.247	Multiplier.
	8848	
	5056	
	2528	
	.0312208	Product.

Example 2d.

Multiply	.13461
by	42
	26922
	53844
	56.5362

Example 3d.

Multiply	3.467
by	19.01
	3467
	31203
	3467
	65.90767

Let it be required to know what is the ſuperficial Content of a Board; the length is ſeven Feet 615 Parts; the Breadth is one Foot 15 Parts? *Anſwer*, 8.75725, or 8 Feet.

Example 4th.

Multiply	7.615
by	1.15
	38075
	7615
	7615
	8.75725

Example 5th.

Let it be required to multiply 2 Shillings and 6 Pence by 2 Shillings and 6 Pence, one Pound the Integer, the Decimal anſwering 2s. 6d. or ¼ of a Pound, is .125

Then I multiply	.125
By the ſame	.125
	625
	250
	125
Facit	.015625 = 0l. 0s. 3d. 3q.

Some of our Pretenders to Art are thunder-ſtruck at this, and abſolutely deny it; not conſidering, that when Fractions are multiplied, they become leſs, in the ſame Proportion as Integers become greater; but to ſilence ſuch, and inform my Reader, I ſhall give a Demonſtration thereof, by the firſt of the ſecond of *Euclid, viz.* Any two Numbers being to be multiplied together, if you divide either or both into as many Parts as you pleaſe, and if you then multiply thoſe Parts one by another, the Sum of thoſe Products will be equal to the Product of one Number multiplied by another.

Now let us divide the former Numbers, one into two Parts, and the other into three Parts.

Firſt, let us divide one into one Shilling, and one Shilling and ſix Pence; and the other into two Shillings and ſix Pence; then multiply thoſe Parts one by another, as follow-

eth,

1ſt,

1*st*,	6 Pence,	by 6 Pence,	or .025	by .025	is=.000625	Products.
2*dly*,	1 Shill.	by 6 Pence,	or .05	by .025	is=.00125	
3*dly*,	1 Shill.	by 6 Pence,	or .05	by .025	is=.00125	
4*thly*,	6 Pence,	by 2 Shill.	or .025	by .1—	is=.0025	
5*thly*,	1 Shill.	by 2 Shill.	or .05	by .1—	is=.005	
6*thly*,	1 Shill.	by 2 Shill.	or .05	by .1—	is=.005	
		The Sum of the Products			.015625	

This Product is the ſame with that which was found by the Multiplication of the two Numbers above; which ſhews the Work to be undeniably right.

But ſuppoſe the former Queſtion was profounded, and a Shilling to be the Integer, then the Work would have been as underneath, and the Product would be 9.25 or 6*s.* 3*d.*

See the Work.

2.5
2.5

125
50

Facit 6.25

Thus you may ſee your Product will alter in Value, according as you alter your Integer.

Example 6th.

	l.	*s.*	*d.*		*l.*	*s.*	*d.*
Let it be required to multiply	5.	12.	9.	By	3.	6.	3.
Decimal anſwering	12*s.*	9*d.*	is	.6375			
And of	6.	3.	is	.3125			

Then Multiply 5.6375
By 3.3125

281875
112750
56375
169125
169125

The Product 18.67421875 = 18*l.* 13*s.* 5*d.* 3*q.*

But inaſmuch as for the moſt part, we have occaſion but for three or four Figures after the *Separatrix*, and ſometimes the Multiplications are long and tedious; I will here give

you a Rule, by which you may contract your Work, and yet ſecure what Places of Decimals you pleaſe; the Rule follows, which you are carefully to obſerve.

Having ſet down your Multiplicand as uſual, ſet the Unit's Place of your Multiplier under that Figure in your Multiplicand, which ſtands as far from Unity as the laſt Figure of your Product is deſired to ſtand, and write the reſt in *inverſe* order; then multiply by your Multiplier as uſual: Only *note*, That you need only begin in your Multiplicand with that Figure that ſtands over the Figure you multiply by; having ſtill a regard to the increaſe that would come from the following Figures of the Multiplicand, placing every ſingle Product exactly even at the right hand (contrary to the common way) and adding them as they ſtand, you muſt cut off ſo many Figures in your Product as was deſigned, which you may better underſtand by the Work of the following Example.

I ſhall by this Method now work the following Queſtion, and cut off but three Figures; whereas in the above Example and Work there were eight Figures cut off; which ſhews the Work to be much contracted, and yet the Product to three Places the ſame as before.

Multiplicand	5.6375
Multiplier tranſverſe	5213.3
	16913
	1691
	56
	11
	3
	18.674

In like manner as before, if .125 were to be multiplied by .125, as in the fifth Example foregoing; and to have four Figures of Decimals after the *Separatrix*:

See the Work.

Multiplicand	.125
Multiplier inverſe	521.
	125
	25
	6
	.0156 = 3*d.* 3*q.*

Here,

Here, becauſe there was but three Places, and my deſign was to have four, I prefix a Cypher; and the Product to four Places is the ſame as in Example the 5th.

Note. When a Decimal Fraction, or mixed Number, is to be multiplied by an Unit with Cyphers (as 10, 100, 1000, &c.) you need only to remove the *Separatrix* ſo many places towards the right hand, as there are Cyphers annexed to the Unit. So if .1278 were to be multiplied,

$$\text{By}\begin{Bmatrix}10\\100\\1000\\10000\end{Bmatrix}\text{The Product will be}\begin{Bmatrix}1.278\\1.278\\1.278\\1.278\end{Bmatrix}$$

DIVISION OF DECIMALS.

DIVISION of Decimals is alſo performed after the ſame manner as Diviſion of whole Numbers; and to know the value of the Quotient, obſerve this:

As many Figures as are cut off in the Dividend, ſo many muſt be cut off in the Diviſor and Quotient; or thus, as many Figures muſt be cut off in the Quotient, as will make thoſe cut off in the Diviſor equal to thoſe cut off in the Dividend; taking notice, if there be not ſo many in the Quotient, that you muſt add Cyphers to the left hand. *Note* alſo, if your Dividend be an Integer, or is leſs cut off than is in the Diviſor; it will be convenient to add Cyphers to the Dividend until they be equal, or more, then the Work will be eaſy.

The following Examples will make all plain:

Example 1ſt.

Divide .78539816 by 217.6

Obſerve as there are 8 Decimals in your Dividend, there are, and muſt be 8 alſo in your Diviſor and Quotient.

```
217.6) .78539816 (003609
       13259...
       20381
        7976
       ------
        1448
       ------
```

Example 2d.

Where the Dividend is a mixed Number, and the Diviſor an Integer.

Divide

Divide 742.651 by 41.

See the Work.

41) 742.651 (18.113 = 18*l.* 2*s.* $3\frac{1}{4}$*d.*
41

332
328

46
41

55
41

141
123

The Quot. is 18.113—18 remains.

Example 3rd.

Where both Numbers are mixed.

Divide 4672.565 by 25.635.

See the Work.

25.635) 4672.565 (182
25635

210906
205080

58265
51270

6995 remains.

In this Example, becauſe there is alike cut off in both, the Quotient is an Integer; and with adding of Cyphers, you may bring it as far after the *Separatrix* as you pleaſe.

Note. The firſt Figure in the Quotient muſt be of the ſame Denomination with that Figure in the Dividend, which at the firſt demand is ſuppoſed to ſtand exactly over the place of Units in the Diviſor.

Example 4th.

Where both Numbers are Decimals, *viz.* Divide .75 by .0125. Seeing I cannot divide, I add Cyphers to the Dividend,

viz.

viz. two, and there will be alike cut off in both; then, as in the laſt Example, the Quotient will be an Integer.

See the Work.

By which you may obſerve, that as Multiplication of Fractions decreaſeth its Value; ſo Diviſion of Fractions increaſes the Value; though contrary in both to the nature of Integers.

.0125) .7500 (60
750
00

Facit 60 in the Quotient.

This laſt Example is the ſame, as if it were demanded to divide 15 Shillings by 3 Pence, the Quotient will be found to be 60 Pounds. The Proof is eaſy by Multiplication.

For if we multiply 3 Pence, or .0125 by 60, the Quotient will be .75, or 15 Shillings.

See the Work.

Supposing ſtill a Pound *Sterl.* to be the Integer.

.0125 the Decimal of 3 Pence;
60
.7500 = 15 Shillings.

Example 5th.

Where the Dividend is an Integer, and the Diviſor a Decimal;

Let it be required to divide 1425, by .6252.

Here before Diviſion can be well made, it will be convenient to add a competent Number of Cyphers.

If you only require the integral Part of the Quotient, add ſo many Cyphers to the Dividend as there are Decimal Parts in your Diviſor; then your Quotient will be wholly integral. But if you require Decimal Parts, ſo many Cyphers more muſt be added (beſides the Number to make them equal) as you deſign to have decimal Parts in your Quotient.

Let us in this Queſtion have three places of Decimals, after the Integral Part of the Quotient.

Se

See the Work.

```
.6252)  1425.0000000  (2279.270
        12504
        -----
         17460
         12504
         -----
          49560
          43764
          -----
           57960
           56268
           -----
            16920
            12504
            -----
             44160
             43764
             -----
              3960 Remainder.
```

The Quotient will be 2279.270

Example 6th.

Where the Dividend is a Decimal, and the Diviſor an Integer:

Let us divide .13975 by 43.

See the Work.

```
43)  .13975  (00325
       129
       ---
       107
        86
        --
        215
        215
        ---
          0
```

When the Diviſion was finiſhed, as you may obſerve, there were but 3 Figures in my Quotient; and inaſmuch as there ſhould be 5 cut off, I therefore annex 2 Cyphers to the left Hand, at in the Example.

And if 5.29125 were divided by 43.5, the Quotient would be .1245.

See

See the Work.

42.5) 5.29125 (.1245
425
1041
850
1912
1700
2125
2125
0

Example 7th.

9.465) 12.43210 (1.31
29671
12760
3295 remains.

Example 8th.

1.47) 3.46000 (2.35⅓
520
790
550
109 remains.

If it be required to divide any Sum by 217.6 the Cubical Inches contained in, or equal to one Gallon of *Ireland.*

The Anſwer may be given by Multiplication only, as in this following Queſtion.

Suppoſe a Brewer's Veſſel be found to be equal to (15724) Cubical Inches, what number of Gallons doth that Veſſel contain?

If you divide (15724) by (217.6) the Quotient will be 72.1 Gallons.

Or, if you multiply (15724) by (.00459) the Product will be 72.1 as before.

☞ This is useful in Guaging.

Example.

15724
.00459
141516
78620
62896
Gallons 72.17316

When any decimal Fraction or mixed Number is to be divided by an Unit, with any Number of Cyphers annexed, it is but removing the *Separatrix* so many Places towards the left hand, as there are Cyphers annexed to the Unit.

So if 17.28 were given to be divided

$$\text{By } \left\{\begin{matrix}10\\100\\1000\\10000\end{matrix}\right\} \text{ The Quotient will be } \left\{\begin{matrix}1.728\\.1728\\.01728\\.001728\end{matrix}\right\}$$

By what goeth before, it may be observed, that if the Dividend be greater than the Divisor, the Quotient will either be an Integer or a mixed Number; but if the Divisor be greater, the Quotient will be a Decimal.

Multiplication and Division in Decimals (as in Integers) interchangeably prove each other, *viz.* to prove Multiplication, divide the Product by the Multiplier, quotes the Multiplicand; or by the Multiplicand, quotes the Multiplier. So to prove Division, multiply the Quotient by the Divisor, produceth the Dividend; or by the Dividend, produceth the Divisor.

Before we leave Division in Decimals, I will give the Learner the Resolution of two excellent Problems, which will be of excellent use.

The First is, having a Multiplicator, how to find a Divisor.

Divide an Unit with Cyphers by the Multiplicator, the Quotient will be the Divisor sought.

Example.

What Divisor is that, by which dividing 7315, shall give a Quotient equal to the Product of the same Number multiplied by 125? *Answer*, .008.

See the Work.

7315
125
36575
14630
7315
914375

125) 1.000 (.008
1.000
0

The Proof

.008) 7315.000 (914375
72.....
11
8
35
32
30
24
60
56
40
40
0

Here you plainly ſee, that the Product and Quotient are the ſame.

The Second is, having a Diviſor, to find the Multiplicator.

This is but the converſe of the former, for if you divide (Unity with Cyphers annexed) by the given Diviſor, the Quotient will be the Multiplicator ſought.

What Multiplicator is that, by which multiplying 7315, ſhall give a Product equal to the Quotient of the ſame Number divided by .008? Anſwer, .125.

See the Work.

,008) 1.000 (.125
8..

20
16

40
40

0

The Proof is in the laſt.

THE GOLDEN RULE IN DECIMALS.

THE Golden-Rule, or the Rule of Three in Decimals, is performed in every reſpect as in whole Numbers, regard being had to the Rules in Decimals before taught; which, if well underſtood, any Queſtion in this Rule, though conſiſting of croſs fractional parts, will receive its reſolution as eaſy, as if the Queſtion was compoſed of Integers only, as ſhall be made plain by the following Examples.

Example 1ſt.

	C.	Qrs.	lb.	l.	s.	d.
If a Cheſt of Sugar, weighing	7.	2.	14.	coſt 36.	12.	9.
what will — — — —	2.	1.	21.	of the ſame Sugar coſt?		

The fractional parts reduced into Decimals, and ſtated as before taught, the work will ſtand thus:

C.		lb.		C.
If 7.625	:	36.6375	::	2.4375

2.4375

1831875
2564625
1099125
1465500
732750

7.625)89.3039062 5(11.71198 *Anſ.* 11*l.* 14*s.* 2*d.* 3$\frac{3}{4}$

The Work at large is left out. Rem. 5875

Queſtion

Queſtion II.

If 16 Pioneers do make a Trench in a Month and 14 Days, how many Pioneers will make the ſame in 12 Days? *Anſ.* 56.

See the Work.

M. *P.* *M.*

If 1.5 : 16 :: .42857

1.5

80

16

.42857)24.00000(56 *Anſw.*

214285

257150

257142

8

☞ In my Product, becauſe I had but one Decimal Place I annexed 4 Cyphers, to equal the number of Decimal Places in my Diviſor, that ſo my Quotient might be an Integer.

Queſtion III.

If when Wheat is ſold for 12 Shillings the Quarter, the Half-penny White-loaf ought to weigh one Pound, one Ounce and twelve Penny-weight; what muſt the Half-penny White-loaf weigh, when Wheat is ſold for 1*l.* 16*s.* 3*d.* the Quarter? *Anſwer*, it ought to weigh 4 Ounces and 10 Penny-weight.

L. *lb.* *L.*

If .6 : 1.1333 :: 1.8125

.6

1.8125) .68000 (.375

54375

136250

126875

93750

90625

31250

Queſtion IV.

What length of a Board of 9 Inches broad will make a ſquare Foot, when 12 times 12, or 144 Inches make one Foot? Say,

Say, if 12 in Breadth require 12 in Length, what will 9 in Breadth require? *Anſwer*, 16 Inches in length.

See the Work.

	B.	*L.*	*B.*
If	12	: 12	:: 9

12

9) 144 (16
9

54
54

0

DOUBLE GOLDEN RULE IN DECIMALS.

IF three Labourers in two Months and 12 Days thraſh 221 Quarters, three Buſhels, and two Pecks of Corn, how much will nine Labourers thraſh in one Month, two Weeks and five Days?

Lab. *Quart.* *Lab.*

Firſt ſay, If 3 thraſh 221.4375 what will 9 thraſh?

Facit — — 664.3158

Say again, If 2.42857 Months thraſh 664.3158 Quarters, what will 1.67857 Months thraſh? *Facit* 459.155, equal to 459 Quarters, one Buſhel and one Peck.

Queſtion II.

If 2 Angels be equal to 20 Shillings, and 15 Shillings equal to 3 Crowns, and 60 Crowns equal to 15 Pounds, and 13 Pounds equal to 12 Guineas: how many Angels will countervail 650 Guineas?

		Shill.	*Ang.*	*Shill.*	
Firſt, I ſay,	If 20	: 2	::	15	*facit* 1.5 Angels.
		Cr.	*Ang.*	*Cr.*	
Secondly,	If 3	: 1.5	::	60	*facit* 30 Angels.
		L.	*Ang.*	*L.*	
Thirdly,	If 15	: 30	::	13	*facit* 26 Angels.
Laſtly,	If 12	: 26	::	650	*facit* 1408.333 Angels.

Anſwer, 1408.333 Ang. or 1408 Ang 3 Shill. and 4 Pence.

The

The laſt Queſtion may be wrought by Diviſion only, by placing your Numbers as underneath.

Here if you multiply the 1ſt, 3d, 5th, 7th and 9th for a Dividend; and the 2d, 4th, 6th, and 8th for a Diviſor, the Quotient is the Anſwer, which you may try at your leiſure.

Thus:
If 2 Angels equal 20s. and 15s. equal to 3 Crowns and 60 Crowns equal 15*l.* and 13*l.* equal 12 Guineas, what will 650 Gui. equal?
Anſwer, 14.08 Angels $\frac{1}{3}$.

In this Queſtion it was required to know how many of the firſt would equal ſuch a Number of the laſt; and is by ſome called the *Compound Rule deſcending*. But if it had been required to know, how many of the laſt would countervail ſuch a Number of the firſt, then in this Queſtion you muſt have multiplied the 2d, 4th, 6th, 8th and 9th for a Dividend; and the Product of the 1ſt, 3d, 5th and 7th would have been your Diviſor; and this is commonly called the *Compound Rule aſcending*.

Queſtion III.

There is a Ciſtern hath 3 Cocks, the firſt will empty the Ciſtern in a quarter of an Hour, the ſecond in half an Hour, the third in three quarters of an Hour; in what time will all the three Cocks empty this Ciſtern?

		H.		*C.*		*H.*	
Firſt,	If	.25	:	1	: : 1	*facit*	4 Ciſterns.
Secondly,	If	.5	:	1	: : 1	*facit*	2 Ciſterns
Thirdly,	If	.75	:	1	: : 1	*facit*	1.333 Ciſterns.

C.

Then ſay, If 7.333 : 1 : : 1. 7.333

1

7.333) 1.0000 (.13637 equal to 8 (Min. 11 Sec. *fere*.
7333

26670
21999

46710
43998

27120
21999

51210
43998

7212

Queſtion

Queſtion IV.

A Cock of a Conduit runneth into a Ciſtern and filleth it in 5 Hours; this Ciſtern hath a Cock that will empty it in 12 Hours: In what time will the Ciſtern be filled if both run at once?

Firſt, I ſay if 5 Hours fill one Ciſtern, what will one Hour fill? *Facit* .2 of a Ciſtern.

Say again, if 12 hours empty one Ciſtern, what will one hour empty? *Facit* .08333 of a Ciſtern.

From	.2 the filling Cock,
Subtract	.08333 the empty Cock,
Differ.	.1167

Then ſay, If .1167 of a Ciſtern require one Hour, what will one Ciſtern require? *Anſwer*, 8.5645, or, 8 Hours, 33 Minutes and 50 Seconds.

Queſtion V.

If Wine worth 15*l.* 12*s.* 9*d.* be ſufficient for the ordinary of 100 Men, when it is worth 25*l* 15*s.* per Tun; what Number will 3*l.* worth ſatisfy, when wine is worth 50*l.* per Tun?

L.	*Men.*	*L.*	*Men.*
Firſt ſay, If 15.6375	: 100	: : 3	*facit* 19.371

Say again, If 25.75*l.* per Tun ſuffice 19.371, what Number of Men will 50*l.* per Tun require? *facit* 10 Men.

And ſo concludes this Rule.

NOTES OF FRUGALITY.

I Shall in this place annex a Queſtion to make the Learner frugal, or a good Huſband, if rightly conſidered; though the Author has as yet only learned it (by the Pen.)

The Queſtion is, If one ſquare Yard of Land coſt a Penny, what will buy an Acre, 160 Perches being an Acre, and 7 Yards a Perch?

Yards

Yards in a Perch 7
Multiply it by 7

Product 49 Square Yards in a Perch.

Perches in an Acre —— 160
Square Yards in a Perch — 49

1440
640

Yards in an Acre —— 7840

At 1 Penny the Yard, what will 7840 Yards coſt?

= 653*s.* 4*d.*
Facit 32*l.* 13*s.* 4*d.*

And the yearly Rent, which 32*l.* 13*s.* 4*d.* will purchaſe at 6 per Cent. Compound Intereſt; or the annual Rent of an Acre, will by the Rules in Compound Intereſt, be found to be 1.96*l.* or 1*l.* 19*s.* 2*d.* 1*q.* $\frac{6}{10}$ very near 40 Shillings.

Whereby it is evident, that he who ſpends one Penny, ſpends or makes away a ſquare Yard of as good Land as any in Ireland, from him and his Heirs for ever; and it is a Queſtion, whether Ireland be worth 20 Shillings an Acre annually, taking one with another; thus, how much good Land we make away, it is eaſy to judge.

For one Penny a Day, is one Pound, one Half-Pound, one Groat, and one Penny in the Revolution of a Year; *viz.* 1*l.* 10*s.* 5*d.* and ſo with 2, 3, 4, 5 Pence, &c.

Here is alſo a compedious method of Buying, or Selling, by the Hundred neat, or Hundred Averdupois, at oft as your Queſtion is but of a ſmall Price.

Firſt, for the Little or true Hundred.

As many Farthings as the Pound coſt, count twice ſo many Shillings, and once ſo many Pence, and that is the Price of the Hundred, *viz.*

At 3½*d.* the Pound, what will the 100 coſt?

	l.	*s.*	*d.*
3½*d.* is 14 Farthings, and twice ſo many Shillings, are 28, or, —— —— —— —— ——	1	8	—
Then once ſo many Pence, are 14, or ——	—	1	2
Anſwer	1	9	2

Here obſerve, for the Great Hundred, or 112 Pounds.

As many Farthings as the Pound coſt, twice ſo many Shillings, and once ſo many Groats, the Hundred Groſs will coſt.

At $2\frac{1}{4}d.$ the Pound, what will the Hundred Averdupois, or 112 Pounds coſt?

	l.	*s.*	*d.*
$2\frac{1}{4}d.$ is 9 Farthings, and twice ſo many Shillings are — — — — —	—	18	—
Then once ſo many Groats, is — — — —	—	3	—
Anſwer	1	1	—

THE EXTRACTION OF THE SQUARE ROOT.

A SQUARE Number is that which is contained under two equal Numbers, or which is equally equal; ſo 4 is a Square Number, contained under two equal Numbers, *viz.* 2 and 2; for 2 times 2 is 4; and the Square Number 9 is contained under 3 and 3; for 3 times 3 is 9; and ſo of the reſt, as in the following Table.

A TABLE OF SQUARES,

With their Genitive Equal Numbers, ſo far as 9 Digits.

Equal Numbers.						Squares.
1	—	into	—	1	— is	1
2	—	into	—	2	— is	4
3	—	into	—	3	— is	9
4	—	into	—	4	— is	16
5	—	into	—	5	— is	25
6	—	into	—	6	— is	36
7	—	into	—	7	— is	49
8	—	into	—	8	— is	64
9	—	into	—	9	— is	81

And

And when it is required to extract the Square Root of any given Number, we have nothing to do but to find that equal Number of which it is compoſed: So if the Root of 16 were required, it would be found to be 4, as in the Table.

Here (4 is the Root,) called by ſome the *Firſt Power.*

And (16 is the Square,) called the *Second Power.*

Of Numbers to be extracted, are three ſorts.

Firſt,	Single,	}
Secondly,	Compound,	}
Thirdly,	Irrational.	}

Single, are ſuch Squares, as are compoſed or made up of any of the 9 Digits, as in the Table.

Compound, are all ſuch Squares, as are compoſed of more Figures than one, as 100, (whoſe Root is 10,) 121, (whoſe Root is 11) or 144, (whoſe Root is 12,) &c.

Irrational, are all ſuch Squares, whoſe Roots cannot be diſcovered by Art exactly, neither in whole Numbers nor Fractions, but ſomething will ſtill remain, there being no Proportion yet found betwixt an irrational Number, and its Root, ſuch Numbers are, 3, 7, 19, 74, 156, 751, &c.

The extraction of the Square Root is not much unlike Diviſion, only there our Diviſor is fixed; and in this we are to ſeek a new one in every operation.

The Root of any ſingle Square Number is found by inſpection, as in the above Table.

But if it be a compound Square Number, it muſt be prepared by pointing, thus: Make a Point under your Unit's Place, and omitting one Figure, point every other Figure, *viz.* point 1ſt, 3d, 5th, 7th, &c and as many Points as your Number contains, ſo many Figures will your Root conſiſt of; then proceed by the following Rule, *viz.*

The Root of your firſt Period you,
Muſt place in Quote if you work true,
Whoſe Square from your ſaid Period then
You muſt ſubduct, and to th' remain
Another period being brought,
You muſt divide as here is taught,
By th' double of your Quote, but ſee
Your Unit's place you do leave free;
Which place will be ſupply'd by the Square
Of your next quoted Figure there:

☞ *This Rule muſt be got by heart perfectly, as the following Work depends upon the Knowledge of it.*

Next multiply, ſubduct, and then
Repeat your work as you began,
If your Number be irrational,
Double Cyphers add for a Decimal.

Example.

Let it be required to find the Square Root of 451584.

Here you may ſee it diſtributed by the Points, into ſevera Squares, and ſhews the Root will have 3 Places, as in the Work.

See the Work.

1. Seek the greateſt Root of your firſt period 45, which by your Table you will find to be 6, which place in your Quotient, and the Square thereof under 45 your firſt period; ſubtract 36 from 45, reſt 9. This is your firſt Work, and no more to be repeated.

2. To the remainder bring down your next Period 15, makes 915 for a Dividend, or as ſome call it, a Reſolvend, as you may ſee in the Work.

3. Double your Quote 6, makes 12 for a Diviſor; then ſeek how oft 12 in 91, or which is the ſame, how oft 1 in 9, (reſerving the Unit's Place for the Square of my ſought Figure) which I find to be 7, which I place in my Quotient; and to ſave trouble of Addition to the right-hand thereof, making it 127; then multiplying 127 by 7, the Product I place under my Dividend, or Reſolvend, as you ſee. This Work is every tin to be repeated.

```
451584 (6
 . . .
 36
 --
  9

451584 (6
 . . .
 36
 --
 915

451584 (67
 . . .
 36
 --
127) 915
     889
     ---
```

4. Sul

4. Subtract 889 from 915, reſt 26, to which I bring down my third and laſt Period 84, then ſhall I have 2684 for a new Dividend, or Reſolvend, as you may ſee in the Work itſelf.

```
451584 (67
 . . .
 36
 ----
127) 915
     889
     ----
      2684
```

5. Double your Quotient 67, *facit*, 134 for a new Diviſor; then I aſk how oft 134 in 268, (ſtill reſerving my Unit's place in the Dividend) or, which is the ſame, how oft 1 in 2?

Anſwer, 2 times, which I place in my Quotient, and likewiſe on the right hand of my Diviſor, making it 1342, then multiplying 1342 by 2, the Product, *viz.* 2684 I place under my Dividend; and ſeeing they are equal, and that nothing remains, I find my Number was a Square Rational Number; and that the Root is 672.

```
451584 (672
 . . .
 36
 ----
127) 915
     889
     ----
1342) 2684
      2684
      ----
         0
```

To prove your Work, Multiply 672 = Root
By —— 672

```
 1344
 4704
 4032
 ----
451584 = given Number.
```

After the like manner the Square Root of 2985984 would be found to be 1728.

But if your Number to be extracted, have a remainder, then you may know it is irrational, and the Root cannot be got exact; although by adding Cyphers, you may come as near the truth as you pleaſe.

Example

Example.

Let it be required to extract the Square Root of 160, or which is the ſame, to find the Length of one ſide of a Square Acre.

See the Work.

```
160) 12.64911
 . .
 1 .
-----
22) 060
    44
   ---
246) 1600
     1476
    ----
2524) 12400
      10096
     -----
25289) 230400
       227601
      ------
252981) 279900
        252981
       -------
2529821) 2691900
         2529821
        --------
          162079
```

Having pointed my Numbers and wrought as before, I find 12 for my neareſt Root, and 16 to remain, to which adding two Cyphers, I find my next Figure to 6, which I cut off from the reſt, as part of a Decimal Fraction; which by continually adding pairs of Cyphers to each Remainder, I increaſe to five Places, which is exact enough; not wanting two Parts, if Unity were divided into a hundred thouſand Parts; for if I Square 12.64911, it will produce 159.999983792 1.

Thus the Square Root of any mixed Number may be found the fractional Part firſt reduced into even Places of Decimals, or ſupplied, if need be: ſo if the Square Root of 17½ were required to three Places of Decimals, the Work would ſtand as below, and the Square Root would be 4.183.

See the Work.

```
17.500000 (4.183
 . . . .
 16
-----
81) 150
    81
   ---
828) 6900
     6624
    ----
8363) 27600
      25089
     -----
      2511
```

The

The Square Root of a Vulgar Fraction, that is commenſurable to its Root, may eaſily be found, by extracting the Square Root of the Numerator, for the Numerator of the Root, and likewiſe the Square of the Denominator, for the Denominator of the ſaid Root, which Fraction is the Root ſought: So if the Square Root of $\frac{4}{49}$ were required, it would be found to be $\frac{2}{7}$, for the Square Root of 9 is 3, and of 49 is 7, equal to $\frac{2}{7}$, and ſo of any other.

After this manner may the Square Root of a mixed Number, which is commenſurable to its Root, be eaſily found.

But if your Fraction be incommenſurable to its Root, then the beſt way will be to reduce it into a Decimal, and extract the Root as before taught.

So if the Square Root of $\frac{3}{80}$ were required into 4 places, it would be 1936, as you ſee in the Work.

$\frac{3}{80}$ is equal to .0375 Then .0375 (.1936

1

29) 275
261

383) 1400
1149

3866) 25100
23196

1904 And ſo farther if you (pleaſe.

But if you would have it to fall in ſome operation, you may prefix its radical ſign before it, thus, $\surd \frac{3}{80}$, and ſo of any other.

In the laſt place, I will ſhew how to find the Square Root of an irrational number nearly, and that without the help of Decimals, and is a very uſeful notion (as I hope will be ſo found) for ſuch as underſtand not thoſe Fractions, and it is thus,

After

After you have found the integral part of your Root to its Quadruple, add Unity for the Denominator of the fractional part, and the remainder doubled is the Numerator: ſo the Root of 160 by this method will be $12\frac{1}{4}$, and thus of any other.

Obſerve this very remarkable Number before we quit the Square Numbers, *viz.* 139854276, this Number, I ſay, is remarkable indeed, for theſe reaſons, *viz.*

First, it is a Square Number,
Secondly, it contains 9 Places, and
Thirdly, they are the 9 Digits.

And I am convinced there is not another Number that does the ſame.

THE EXTRACTION OF THE CUBE ROOT.

THOUGH the practice of this Extraction may at firſt ſight ſeem ſomething difficult; yet the reaſon and demonſtration of it, will, I doubt not, make the learner a recompence.

Euclid, Lib. 7. Defin. 19.

A Cube, *ſays he, is that Number which is equally equal, or which is contained under three equal Numbers.*

So 8 is a *Cube-number*, contained under three equal Numbers, *viz.* 2, 2 and 2, for two times two is 4, and two times 4 is 8; and the Cube-number 27, is contained under 3, 3 and 3, for three times three is 9, and three times 9 is 27; and ſo of the reſt, as in the following Table.

A Table

A Table of Cubes, with their genitive equal Numbers, as far as the 9 Digits.

EQUAL NUMBERS.									CUBES.
1	—	into	1	—	into	1	—	is	1
2	—	into	2	—	into	2	—	is	8
3	—	into	3	—	into	3	—	is	27
4	—	into	4	—	into	4	—	is	64
5	—	into	5	—	into	5	—	is	125
6	—	into	6	—	into	6	—	is	216
7	—	into	7	—	into	7	—	is	343
8	—	into	8	—	into	8	—	is	512
9	—	into	9	—	into	9	—	is	729

And when it is required to extract the Cube Root of any given Number, we have only to find that equal Number of which it is compoſed; ſo if the Root of 64 was required, it would be found to be 4, as in the Table.

(Here 4 is the Root) or firſt Power, and 4 times 4 is 16 the ſecond Power, and 4 times 16 is 64, or the third Power, (which is the Cube.)

Of Cube Numbers to be extracted, are three Sorts, viz.

Firſt, *Single*,
Secondly, *Compound*,
Thirdly, *Irrational*.

Single, are all ſuch Cubes as are compoſed, or made up of any of the 9 Digits, of which ſort are thoſe in the above Table.

Compound, are all ſuch Cubes as are compoſed of more Figures than one, as, 100, whoſe Root is 10; 1331, whoſe Root is 11; or, 1728, whoſe Root is 12, and ſo on.

Irrational, are all ſuch Cubes, whoſe Root cannot be diſcovered exactly by Art, neither in whole Numbers nor Fractions, but ſomething will ſtill remain; their being no Proportion as yet found betwixt an Irrational or Surd Number, and its Root; ſuch Numbers are 5, 7, 36, 160, 1526, &c.

The Extraction of the Cube Root participates ſomething of the Nature of Diviſion, yet a deal more difficult; the Root of any

ſingle Cube number is found by inſpection; as in the foregoing Table; but if it be a Compound Cube Number, it muſt be prepared by pointing thus: make a point under your Units place, and omitting two, point every third Figure; and as many Points as your Number contains, ſo many Figures will your Root conſiſt of; then obſerve you muſt get well by heart the following Rule.

The Cube of your firſt Period take,
And of its Root a Quotient make;
Which Root into a Cube muſt grow,
And from your Period taken fro';
To the Remainder then you muſt,
Bring down another Period juſt;
Which being done then muſt you ſee,
Your number ſtraight divided be
By juſt 300 times the Square,
Of what your Quotient Figures bear;
Which do ſo that you in may take;
The Fact your Quotient Figures make;
Laſt ſquar'd, and multiply'd by th' reſt,
And Product thirty times expreſſed,
The Cube of laſt found Figure too,
You muſt put in if right you do;
Repeat your Work and ſo deſcend
From point to point unto the end,
Then are you right, as I'm your Friend,
All done if ought remain there ſhall,
Add triple Noughts for a Decimal.

*** See the Rule

What a Cube is, may be well repreſented by a Die, which is a little Cube itſelf, being a rectangular or ſquare Solid, that hath an equal Length, Breadth and Depth, and is comprehended under ſix equal Squares.

1st *Example.*

Let it be required to extract the Cube Root of 46656.

1st, Point your Number as directed, whereby you may ſee the Root will have but two places. 46656 (3

2d, Seek the greateſt Root of your firſt Period 46, which by the foregoing Table you will find to be 3, which place in your Quotient, and the Cube thereof 27, place under 46; ſubtract 27 from 46, and there will reſt 19, as you ſee if you obſerve the Work. Now this is your firſt Work, and not to be repeated.

27
19

3d, To

3d, To your Remainder 19, bring down your next and laſt Period 656, and it will make 19656 for a Dividend; then ſquare your Quotient 3, makes 9, which multiplied by 300, produceth 2700 for a Diviſor: ſeek how oft 2 in 19? *Anſwer* but 6 times, (becauſe of the increaſe that will come from my Quotient) then multiply my diviſor by 6, and the product 16200 I place orderly under my dividend, having ſeparated them with a ſmall line; then proceed to find the increaſe coming from my Quotient, thus, ſquare your laſt figure 6, *facit* 36; which multiply by the reſt of your Quotient; here, by 3 *facit* 108, and this by 30, *facit* 3240 which I place orderly under my laſt Number 16200, then cube the laſt figure placed in your Quotient, here 6 *facit* 216, which I alſo place orderly under my laſt number 3240, and I add my three Subducends (for ſo many I muſt have in every operation after the firſt) into one ſum, *facit* 19656; and ſeeing it is equal to my Dividend, and no more Periods to bring down, I ſee my Work is finiſhed, and my number a right Cube Number, and the Root is 36.

Note. As many Operations or Periods as you have (except the firſt) ſo oft this laſt Work is to be repeated.

Now that I have given proper directions for working the laſt Example, ſee the Work itſelf.

46656 (36 Quote equal to the Root.

27

2700)19656 Dividend.

16200
3240 } Subducends.
216

Sum 19656 From Dividend ſubtract.

Reſt. 00

Root 36
36

216
108

Square 1296

Proof.

Square 1296
Root 36

7776
3888

46656 Cube.

2d *Example.*

Let it be required to find the Cube Root of this Number, 673373097125.

1st. I point my Number, by which I ſee my Root will have four places as in the Work below.

2d Seek the greateſt Root of your firſt Period 673, which by the Table is 8, which place in you Quote, and the Cube thereof 512, place under 673, and ſubtract, reſts 161.

```
                    673373097125 (8
                    . . . .
                    512
This is your firſt Work,  ------
and not to be repeated    161
```

3d. To the Remainder 161, bring down your next Period 373, and it will make 161373 for a Dividend; (to which 19200, being 300 times the Square of 8 your Quotient, is a Diviſor.) And conſidering how oft my Diviſor is contained in my Dividend (ſo as to allow place for my Subducends) I find it 7 times; place 7 in the Quotient, by which multiplying my Diviſor, the Product I place under my Dividend for my firſt Subducend; next I ſquare my laſt figure 7, which multiplied by 8, and then by 30, gives 11760 for my ſecond Subducend, which I place under my laſt, and the Cube of 7, my laſt quoted Figure, is my third Subducend, which I place under the two, and adding them, the Sum is 146503, which I ſubtract from my Dividend, and the Remainder is 14870, then will the Work appear thus.

```
                    673373097125 (87
                    . . . .
                    512
                    ------
   1st Diviſor 19200) 161373 Dividend 1st.
                      ------
        134400 }
         11760 } Subducends.
           343 }
        ------
Sum     146503  From Dividend ſubtracted.
        ------
Reſt    14870
```

4th. To

4th, To this Remainder bring down your next Period, *viz.* 097, then will your ſecond Dividend be 14870097; (to which 2270700 being 300 times the Square of the Quotient 87) is a Diviſor, and dividing by the caution before given, I find the next Figure of my Root to be 6, and my firſt Subducend is 13624200; ſquare 6, *facit* 36, which multiplied by 87, makes 3132, and this by 30 gives 93960 for my ſecond Subducend, and the Cube of 6, which is 216, is my third Subducend, which placed as before taught, and as in the Work, and then added, the Sum is 13718376, which I ſubtract from my laſt Dividend, and the Remainder is, 1151721.

Then will the Work ſtand thus.

673373097125 (876

512

(1ſt,) Diviſor 19200) 161373 Dividend (1ſt,)

134400
11760 } Subducends.
343

Sum 146503 From Dividend ſubtract.

(2d,) Diviſor 2270700) 14870097 Dividend (2d,)

13624200
93960 } Subducends.
216

Sum 13718376 From Dividend ſubtract.

Reſts 1151721

5th, To this Remainder bring down the laſt period, 125, and your third and laſt Dividend will be 1151721125, to which 2302128oo is Diviſor; which is 300 times the Square of 876 your Quotient; and dividing as before, I find my fourth Figure to be 5, and my firſt Subducend is 1151064000, and multiply 876 by the Square of 5, and that by 30, gives 657000 for my ſecond Subducend, and the Cube of 5, *viz.* 125 is my third Subducend, which added, the Sum makes 1151721125, and ſeeing it is equal to my laſt Dividend, and no more to bring down, I ſee my work is finiſhed, and the Number given a right Cube Number; and my Root ſought is 8765: And now obſerve the whole work together, which appears as follows:

So

See the whole Work.

673373097125 (8765
. . . .
512

(1ſt,) Diviſor 19200) 161373 Dividend (1ſt,)

134400
11760 } Subducends.
343

Sum = 146503 From Dividend ſubtracted.

(2d) Diviſor 2270700) 14870097 Dividend (2d,)

13624200
93960 } Subducends.
216

Sum = 13718376 From Dividend ſubtract.

(3d) Diviſor 230212800) 1151721125 Dividend (3d,)

1151064000
657000 } Subducends.
125

Sum = 1151721125 From Dividend ſubtract.

Reſt 00

Proof.

Root 8765 } Multipl. 8765 } Multiply By 76825225 Square, 8765 the Root.

43825
52590
61355
70120

76825225 Square

384126125
460951350
537776575
614601800

673373097125 Cube.

Where

Where your mixed Number or Fraction is commenſurable to its Root, then you may extract the Cube Root of the Numerator for the Numerator of the Root, and the Cube Root of the Denominator for the Denominator of the ſaid Root, ſo the Cube Root of $\frac{27}{64}$ will be $\frac{3}{4}$, for the Cube Root of 27 is 3, and of 64 is 4; which is $\frac{3}{4}$, and ſo of any other.

But if your Fraction or mixed Number be incommenſurable to its Root, you muſt work as before; or if you have no preſent occaſion for it, you may prefix its Redical Sign; ſo the Cube Root of $\frac{11}{19}$ would be expreſſed thus, $\sqrt[3]{c}\,\frac{11}{19}$ or $\sqrt[3]{\ }\,\frac{11}{19}$, and ſo of any other.

As in the Square Root, ſo here I will ſhew you how to find the Cube Root of an irrational Number near, without the uſe of Decimal Fractions, and it is thus.

After you have found the Integral part of your Root, to the treble thereof add Unity, and that Sum added to the Square of the ſaid Root tripled, is the Denominator, to which the Remainder is Numerator; or which is the ſame, if you find the difference betwixt the Cube of the Root and the Cube of the Root *plus* Unity, you have the Denominator as before.

Here obſerve the uſe of the Square and Cube Roots.

Here follows ſome uſe of the Square and Cube Roots, both in Arithmetick and Geometry.

Problem I.

To find a mean Proportional between any two Numbers given.

Rule.

The Square Root of the Product of the given Numbers is the mean Proportional ſought.

So a mean proportional betwixt 16 and 64 will be 32.

This Problem is of excellent uſe in finding the ſide of a Square equal to any Parallelogram, Rhombus, Rhomboides, Triangle, or Regular Polygon.

For if in a Parallelogram you ſuppoſe the two Sides, or in a Rhombus or Rhomboides, the Side and Perpendicular falling thereon; in a Triangle, the Baſe and $\frac{1}{2}$ the Perpendicular, or the Perpendicular and $\frac{1}{2}$ the Baſe; and in a Regular Polygon, the $\frac{1}{2}$ Perimeter (or by ſome called the Circ, or Periphery) and the Perpendicular; or $\frac{1}{2}$ Perpendicular and Perimeter; I ſay,

if

if you ſuppoſe them as two Numbers given, and by the foregoing Problem find a mean Proportional given, is the Side of a Square equal ſought.

From this Problem by conſequence follows,

Problem II.

To find the Side of a Square equal in Area to any given Superficies whatſoever.

Rule.

The Square Root of the Content of any given Superficies is the Side of the Square equal ſought.

So if the Content of a given Circle be 160, the Side of the Square equal will be $12\frac{1}{49}$ *fere*; or more exact in Decimals, 12.64911.

Here if you ſuppoſe the Content to be the Product of two Numbers, as in many caſes it is, it will be the ſame as to find a mean Proportional betwixt thoſe two Numbers.

Problem III.

The Area of a Circle given, to find the Diameter.

Rule.

As 355 : to 452, or, as 1 to 1 .273239 : : ſo the Area : to the Square of the Diameter.

What length of a Cord will be ſufficient to tie to a Cow's Tail, the other end fixed in the ground, to let her have the liberty of eating an Acre of Graſs and no more, ſuppoſing the Cow and Tail to be 5 Yards and a half?

Say, As 355 : to 452 : : ſo 160, being the Area of a Circle whoſe Content is an Acre : to 203 .7183, whoſe Square Root is the Diameter, *viz.* 14.273 Perches, the Semi diameter is 7.136, from which ſubtract one Perch for the Cow and Tail, reſt 6.136 Perch for the length of the cord.

Problem IV.

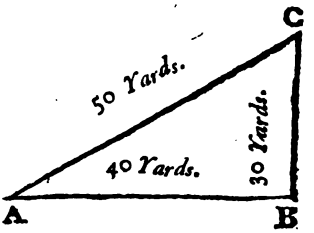
Any two ſides of a right-angled Triangle being given to find the third Side.

In this uſeful Problem lies hid a great part of the Mathematicks; the invention whereof is fathered upon *Pythagoras*, the Demonſtration thereof *Euclid* has in the 47th *Propoſition* of the *Firſt Book* of his *Elements of Geometry*, where it is proved that the Square of the *Hypothenuſe*, or longeſt ſide of a right-angled Triangle, is equal to the ſum of the Squares of the Baſe and Perpendicular; or the other two ſides.

In

In the annexed Triangle A B C, let the Baſe or Ground A B repreſent the Breadth of a Mote or Ditch, and let the Perpendicular B C repreſent the height of a Caſtle, Tower, or City-wall; and let the Hypothenuſe, or longeſt ſide, repreſent the length of a Scaling Ladder.

Let the Baſe A B, or the breadth of the Ditch be 40 Yards, and the Perpendicular B C, or the height of the Wall be 30 Yards; what length will the Hypothenuſe A C, or the Scaling-Ladder be?



Rule.

The Square-Root of the Sum of the Squares of the Baſe and Perpendicular, is the length of the Hypothenuſe.

Answer 50 Yards the length of the Ladder.

For the Square of the Baſe 40 is —— 1600
And the Square of the Perpendicular 30 is 900

The Sum — 2500 (50 *the Root*
25
000

But if the breadth of the Ditch was required, and the Perpendicular and Hypothenuſe were given, then this is

The Rule.

The Square Root of the difference of the Squares of the Hypothenuſe and Perpendicular, is the length of the Baſe, or breadth of the Ditch.

For the Square of the Hypoth. A C, is——2500
And the Square of the Perpendicular B C, is——900

Diff.—— 1600 (40 *the Root.*
16
900

Here you ſee the Baſe is 40.

And

And if B C were required from the given ſides A B and A C, then the Square Root of the difference of the Squares of the Hypothenuſe and Baſe, is the height of the Perpendicular, or B C.

The chief use of the Cube Root is to find out a Proportion between like Solids, as Globes, Cylinders, Cubes, &c.

Problem I.

If a Bullet of Braſs of 8 Inches diameter weighs 72 Pounds, what ſhall a Bullet of Braſs weigh whoſe diameter is 4 inches?

Rule.

Since like Solids are in trible Proportion to their Homologous ſides, *viz.* Diameters, Lines, &c. it holds thus,

As the Cube of the Diameter given:
To the Weight thereof: :
So the Cube of the Diameter ſought:
To the Weight thereof.

See the Work.

	C.D.		lb.		C.D.
If	512	:	72	: :	64
			64		
			288		
			432		
			4608		
	512)		4608	(9	
			4608		
			0		

Facit 9 *Pound.*

Problem II.

To find the ſide of a Cube that ſhall be equal in Solidity to any given Solid, as Globe, Cylinder, Priſm, Cone, or ſuch like.

Rule.

The Cube Root of the Solid content of any Solid Body given, is the ſide of the Cube of equal Solidity.

So, if the content of a Globe was found to be 15625 Solid Inches, ſeek the Cube Root of 15625, which is 25, which is the Side of a Cube of equal capacity.

So much as to the use of the Square and Cube Roots.

To

To find the Square and Cube Root by the Sliding Rule.

As I have juſt been ſhewing the uſe of the *Square* and *Cube Roots*, and am juſt upon ſhewing the uſe of the *Sliding Rule* upon another occaſion. I ſhall before I begin any other thing, ſhew you its uſe upon this very occaſion.

The Extraction of Roots is one of the hardeſt leſſons in Arithmetick, yet by the help of this inſtrument it may be performed with leſs trouble than by the Pen: For if the Lines C and D, be exactly applied, ſo that 10 at the end of D, be even with 10 at the end of C; I ſay the lines thus applied are like a table ſhewing the Square Root of any Number by inſpection only; for againſt any Number upon C, you have the Square Root thereof upon D, & *contr.*

Note 1ſt, When the figures in the Number given are even, *viz.* when the Number conſiſts of 2, 4, 6, or 8 Figures (being Integers) look the ſame in the ſecond Radius of the line C, and againſt it you have the Square Root upon D: And in this caſe the ſaid Root will ever conſiſt of half as many figures as the Number given.

Example.

Let 16 be the Number propounded, I ſeek 16 in the 2*d.* Radius upon C, and againſt it upon D, I find 4 the Square Root required.

And likewiſe $\left\{\begin{matrix}5.5\\48\\886\end{matrix}\right\}$ is the Root of $\left\{\begin{matrix}30.25\\2304\\784996\end{matrix}\right\}$

2d. When the Integers in the Number given are odd, *viz.* 1, 3, 5, or 7, ſeek it upon the firſt Radius upon the line C, and againſt it you have the Root ſought: And in this caſe the Root will have half as many Figures as the Numbers given, and one more.

Example.

Let the Number given be 156.25, I ſeek this upon the firſt Radius of the line C, and againſt it I find 12.5 the Root ſought.

And likewiſe $\left\{\begin{matrix}24\\144\\1000\end{matrix}\right\}$ is the Root of $\left\{\begin{matrix}576\\20736\\1000000\end{matrix}\right\}$

Note, *That what you call the First Radius, is that part of the Rule from Number* 1 *beginning at the left hand of the Rule, to Number* 10 *on the middle of the Rule; and paſt that, is called the Second Radius*, &c. *remembering* B *to be the fourth Radius.*

To find the Cube Root by the Sliding Rule.

Place the Lines D and E exactly one by another, ſo that 10 at the end of D, be even with 10 at the end of E; this done, againſt any Number upon E, you have the *Cube Root* thereof upon D, & *contr.*

Note 1ſt, when the Number given conſiſts of 1, 4, or 7 Figures (being Integers) find it in the firſt Radius of the Line E, and againſt it you have the Cube Root ſought.

Example.

Let the Number given be 3375, I ſeek this in the firſt Radius on the Line E, and againſt it I find 15 upon D, which is the Cube Root of 3357; and ſo is 212 the Cube Root of 9528128.

2dly, When the Number given conſiſts of 2, 5, or 8 Integers, find it in the 2d Radius upon E, and againſt it is the Root ſought.

Example.

Suppoſe 35.937 were propounded, find this in the 2d. Radius on the Line E, and againſt it is 3 .3 the Cube Root upon D: in like manner 275 the Cube Root of 20796875.

3dly, When the Number given conſiſts of 3, 6, or 9 Integers, it muſt be ſought in the Third Radius, &c. for againſt it is the Cube Root: Thus againſt 125 in the Third Radius upon E, I find 5 the Cube Root; and ſo likewiſe is 888 the Cube Root of 700227072.

Lastly, To know how many Places of Integers muſt be in the Cube Root of any Number given.

Put a Point under the place of Units in the Number given, then omitting 2, point every third Figure towards the left hand; then tell how many, for ſo many places of Integers muſt the Cube Root conſiſt of.

STEREOMETRY,

OR THE

ART OF GAUGING,

BOTH IN THE

THEORY AND PRACTICE,

Together with the Use of the

Sliding Rule and Tables.

TO THE

EXCISE OFFICERS

OF

IRELAND.

Gentlemen,

If the following directions prove useful to you, then have you amply satisfied

Your loving Brother,

JOHN BALLARD.

VOX AUDITA PERIT, LITERA SCRIPTA MANET.

Will no superior Genius snatch the quill;
And save me on the brink, from writing ill?

STEREOMETRY,

OR

GAUGING.

STEREOMETRY or GAUGING, is that part of the Mathematicks ſpringing from Geometry; by which the contents of all regular ſolid bodies are diſcovered; as the end and ſcope of Geometry is to meaſure well.

Vide Plato, Lib. 7. de Rep.—*Ejus cognitio quod ſemper eſt, ac tollet igitur (O Generoſe Vir!) ad veritatem animam: atq; ita, ad Philoſophandum præparavit cogitationem, ut ad ſupera convertamus: quæ nunc, contra quam docet, ad inferiora dejicimus, &c.*

In Guaging there are two things chiefly neceſſary to be noted, and yet both controverted, viz.

Firſt, That ſeeing all manner of Caſks made to contain Liquor, are for the moſt part the trunk of a Spheroid, cut off with two circles, at Rectangles with the Baſe, and therefore irregular.

The Second thing to be noted is, how to find the true quantity of an Ale Gallon in Cubic Inches, for in this ſeveral Artiſts differ in their experiments: see Dr. Wybard, Mr. Oughtread, and many others: and in England the Ale Gallon is to contain 282 Cube Inches; but here in Ireland, the Gallon is allowed to contain 217 Cube Inches and 6 Tenths: therefore they muſt firſt be reduced into a regular proportion. (This premiſed) I think it not impertinent, to obſerve to you, that every magnitude muſt be meaſured by ſome known kind of magnitude that is Homogeneal (or like) to it: A Superficies is meaſured by a Superficies, as one Square Inch, one Square Foot, &c.

A Solid

A Solid is meaſured by a Solid, as one Cubic Inch, one Cubic Foot, &c. and when this is rightly underſtood, then is the quantity or content of either of theſe kinds ſaid to be known.

First, to Guage Superficies, and First a Circle.

By way of introduction, as alſo for method's ſake, I hold it proper to begin with the definition thereof.

Definition.

A *Circle* is a plain Figure contained under one Line, ſo drawn into itſelf, as that it is every where equally diſtant from the middle or centre.

There are three Parts neceſſary to be underſtood in a Circle.

Theſe are { The *Diameter*, / The *Circumference*, and / The *Area*.

The *Diameter* is a ſtraight line paſſing through the midſt of the Circle, dividing the whole into two Semi-Circles.

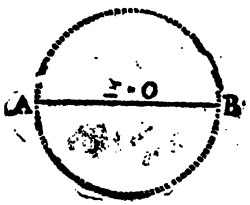
The *Circumference* is the uttermoſt bounds, or line that deſcribes the Circle, by ſome called the *Periphery*.

The *Area* is all the ſpace contained within the *Circumference*.

Problem I.

Having the Diameter of a Circle, as A B, to find the Area or ſuperficial Content, firſt in Inches and Parts, and afterwards in Gallons and Parts. The proportion is thus: As 14 is to 11, ſo is the Square of the Diameter, to its Area in Inches and Parts; which Area being divided by 217 .6 the Cubical Inches in the *Iriſh* Ale Gallon, the Product is the Area in Gallons and Parts.

See Euclid Problem 8.



Example

Example.

Diameter 1.
1.

1.
11.

14) 11.000000 (.785714 the Area in parts of an Inch.
98 . . . . .

120
112

..80.
70

100
98

20
14

60
56

(4)

217 .6 (.785714) .00361 Area in parts of a Gallon.
6528 . .

13291
13056

. . 2354
2176

(178)

By the foregoing Rule the Area of the Circle, whose Diameter is Unity, or one Inch, is found to be .00361, and all Circles Areas are in proportion one to another, as the Squares of their Diameters: therefore, if the Square of any other Circle's Diameter be multiplied by the above .00361, it gives the Area of any such Circle.

Note, If you divide an Unit with a competent number of Cyphers by .00361, the Quotient is a Diviſor, or a Unit by a Diviſor, and the Quotient is the Multiplicator; by which having any Diviſor you may find a Multiplicator; & *contra*, having a Multiplicator, you may find a Diviſor.

Note, That if the Square of any Circle's Diameter be multiplied by .00361, or divided by 277—either the Product or the quote will be the Area in Gallons and Parts; and the reaſon is this, that this Multiplicator .00361 which is generally uſed, is the Area of a Circle in parts of a Gallon, whoſe Diameter is one Inch; or it is the complement Arithmetick to the Gauge-Point.

Alſo this Diviſor, 277—is the Square of the Gauge-Point.

I have here inſerted the proper Diviſors and Multiplicators for Squares and Circles, and for the wet and dry Maſhes in Circular and Priſmoidical Maſh-Tuns.

The Cubical or Solid Inches contained in the liquid Gallon in *Ireland* are — —	277.6
Which is a common Diviſor for Squares.	
The Multiplicator is — — — —	.0046
The Diviſor for goods in Squares — —	181—
Multiplicator — — — —	.0055
Diviſor for the Wet Maſh is — — —	326.4
Multiplicator is in Squares — — —	.0024
Diviſor for Circles is — — —	277 —
Multiplicator — — — —	.00361
Gauge Point — — — —	16.64
Diviſor for the goods in Circles — —	231 —
Multiplicator is — — — —	.0043
Gauge Point — — — —	15.2
Diviſor for Wet Maſh in Circles is — —	416 —
Multiplicator is — — — —	.0024
Gauge Point — — — —	20.3—

Now by the Sliding Rule.

I have ſhewn already how the Area of a Circle, whoſe Diameter is 1 .0 may be found by the Pen, and alſo the content in Gallons; and I now come to ſhew you how each may be found by the Rule.

But

But you muſt carefully obſerve, that 16.64 is the Diameter of a Circle whoſe Area is 217.6 therefore 16.64 is the Gauge Point for finding the Area in Gallons.

And for the ſame reaſon, 94.15 muſt be the Gauge Point, for finding the Area in Barrels: for Note, theſe Gauge Points are the Square Roots of the fixt Diviſors, as will appear by the Rule: for ſetting the lines C and D, even at the end.

Againſt 277.0 upon C, you have 16.64 upon D.

Alſo againſt 8865.8 upon C, you have 94.15 upon D.

(This allowed) having found the Diameter of the foregoing Circle to be 1.0, I demand the Area in Gallons by the Rule of another Circle whoſe Diameter is 16.7 and Depth 6.6?

By the Rule.

Set 1. upon line C, to the Gauge Point upon line D, then under the Diameter 16.7 upon line D, you have the Area, viz. 1. upon line C.

I have found the Area, I now demand the content of ſaid Circle in Gallons.

Set the Area on line B, to Unity on line A, then under the wet on line A, you have the content on line B; and the ſame per contra.

Having the Diameter and Depth, to find the content.

Set 6.6 the Depth upon line C, to the Gauge Point for Gallons on line D, then under the Diameter, viz. 16.7 upon line D, you have 6.6 the number of Gallons on line C, which is the ſame with the Work by the Pen.

Note, when the Area of a Circle is ſought in Gallons, if the Diameter be more than 16.64, and leſs than 100, ſet the Gauge Point to 1. at the beginning of line C, then againſt any Diameter between 16.64 and 100 you have the Area upon C: But if the Diameter be leſs than 16.64 or greater than 100, ſet the Gauge Point to 1. in the middle of line C.

Problem II.

The Diameter and Area of the forementioned Circle being found already, now I demand the Circumference of the ſaid Circle?

In order to anſwer this by the Pen, you muſt multiply the Diameter of ſaid Circle by (22) and devide the Product by (7) the Quotient ſhall be the Circumference.

Or, multiply the Diameter by 3.141592, the Product ſhall be the Circumference nearer; for Note, as 1. is to 3 141592, ſo is the Diameter (of any Circle) to the Circumference.

See the Work.

16.7 the Diameter,
22 multipl.

334
334

7) 367.4 (52.4 the Circumference near.
35

17
14

34
28

6

Now by the Sliding Rule.

Set 1. on the line A, againſt 3.141, &c. on line B; this done, againſt any Diameter on line A, you have the Circumference on line B; and conſequently under 16.7 the Diameter of this Circle upon line A, you have 52.4, which is near the Circumference, on line B: but if you multiply as above directed you will come nearer.

How to Gauge an Ellipsis, or Oblong Circle.

Definition.

AN *Ellipsis, (*or *Oblong Circle)* is a plain figure contained under one line, made by the *Scalene* ſection of a Cone under the Vertex, through both the ſides, in which the longeſt Diameter is called the Axis of *Transverse*, and the other cutting former at Right Angles in the centre, is called the *Conjugate* or intercepted Diameter.

Problem III.

Given CD and EF, (as in the oppoſite figure) the *Transverse* and *Conjugate* Diameters of the *Ellipsis*, to find the Area.

By

By the Pen.

Multiply the greater Diameter by the leſſer; and then

If you either multiply the product by .00361 } The product of the former or
Or divide the product by 277.05 } Quotient of the latter. } will be the Area in Gallons.

See the following Work.

Greater Diameter — — — 87
Leſſer — — — — 68 } Inches.
Depth — — — — 7.5

Suppoſe CD = 87
EF = 68 } Inches.

696
522

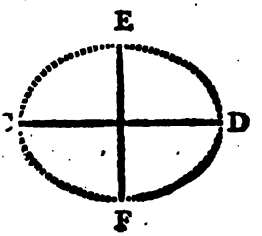
277.05) 5916.0000)21.35 Area in Gallons.
37500 . . .
97950
148350

9825

21.35 Area
7.5 Depth.

10675
14945

160.125 the whole Cont.



But

But if you desire to know the Area in Inches only, multiply the Rectangle or Product of CD and EF by .7854.

CD —— 87	
EF —— 68	
696	
522	
Rectangle —— 5916	
.7854	
.23664	
29580	
47328	
41412	
Area in Inches 4646.4264	

☞ *Note.* That Brewers Tuns are moſt commonly Segments of Cones or Pyramids, whoſe Baſes are either a Square Parallelogram, Circle, or Oval; to meaſure which, let their Forms be what they will, you muſt do thus: You muſt firſt find their ſolid content in Cubic Inches by the common rules of meaſuring Segments or Bodies, which content you muſt divide by 217.6 (Inches in one Gallon) and that gives the content in Gallons; then dividing the Gallons by 32 (the number of Gallons in a Barrel) it ſhews the content in Barrels; and the ſame in all other caſes.

By the Sliding Rule thus:

Set (68 or 87) your choice upon line B, to 277.05 upon line A, and againſt the other Diameter on line A, you have 21.3 the Area upon line B, which agrees with the Pen in the above work.

Then ſet 21.3 the Area upon line B, to Unity or 1. on line A, and under 7.5 the Depth on line A, you have 160 the whole content on line B.

☞ *Note.* That for expedition in common buſineſs, and to avoid miſtakes in great operations, I recommend the following Factors, which you'll find oft uſed in the following Treatiſe, *viz.*

In all Rectilineal Figures, uſe .0046, for .004595588, &c.

In all Curvilineal Figures, uſe .00361, for .003609366, &c.

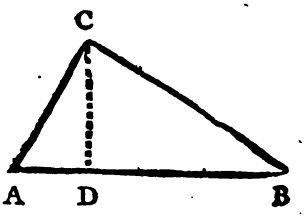
To

To find the Area of a Triangle.

Definition.

A Right-lined plain Triangle, is a Figure conſtituted by Three Right Lines including Three Angles.

In all Right-lined Triangles, multiply half the Baſe (or longeſt ſide) by the Perpendicular, or neareſt diſtance from the Baſe to the oppoſite Angle; the Product is the Area in Inches, which divided by 217.6, or multiplied by .0046, gives the Area or content upon an Inch in Ale Gallons.



Problem IV.

The Baſe AB, and Perpendicular CD, of a right lined plain Triangle given to find the Area.

Suppoſe, AB=112, and CD=50 Inches.

½ AB=56
CD=50

Area in Inches 2800 217.6) 2800.000 (12.86 *Area in Gallons.*
6240 50 *the Depth.*
18880
14720 643.00 *the whole Cont.*
1664

Note. If you multiply half the Perpendicular by the whole Baſe, the Product will be the Area required.

Now by the Sliding Rule.

Set 56 (half the Baſe) upon line B, to 217.6 upon line A, then under 50 upon line A, you have 12.8 the Area upon line B.

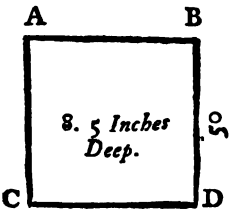
Then

Then ſet 12.8 the Area on line B, to Unit or 1. on line A, and under 50 upon line A, you have 643 the whole content upon line B.

To Gauge a Right-Angled Parallelogram, or Square Cooler.

Definition.

A SQUARE is a Figure contained under four equal Sides, and as many Right Angles.



Firſt multiply the Side of the Square Cooler into itſelf, the Product is the Area in Square Inches, which divided by 217.6 or multiplied by 0046, gives the Area in Gallons upon one Inch deep; and laſtly, if the ſaid Area in Gallons be multiplied by the Depth of the liquor, the Product will be the content of that liquor in Gallons.

Problem V.

Suppoſe AB=50 Inches,

50

Area in Square Inches 2500

217.6) 2500.000 (11.48 Area in Gallons.

3240 . .
10640
19360
1952

11.48 *Area in Gallons.*
8.5 *Depth.*

5740
9184

97.580 *the whole Content.*

Now

Now by the Sliding Rule.

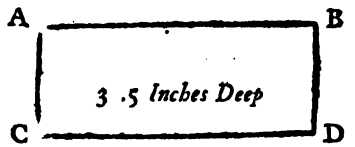
Set 50 on line B, to 217.6 upon line A, then under 50 on line A, you have 11.4 the Area on line B.

Then set 11.4 the Area upon line B, to Unit or 1 on line A, and under 8.5 the depth on line A, you have 97.5 the whole content on line B.

To Gauge an Oblong Cooler.

Definition.

AN Oblong is a four sided figure, whose Angles are all right, and opposite sides equal.



Multiply AB by BD, the Product is the Area in Inches, which divided by 217.6, or multiplied by .0046, gives the Area in Gallons, and that Area multiplied by 3.5 the depth, its Product is the whole content in Gallons.

Problem VI.

Suppose AB = 112, and BD = 50 Inches.

50

Area in Inches 5600

217.6) 5600.000 (25.73 Area in Gallons.
12480..
16000
7680
1152

25.73 Area in Gallons,
3.5 Depth.

12865
7719

90.055 the whole content.

Now by the Sliding Rule.

Set 112 upon line B, to 217.6 upon line A, then under 50 on line A, you have 25.7 the Area in Gallons on line B.

Then ſet 25.7 the Area upon line B, to Unit or 1 on line A, and under 3.5 the Depth upon line A, you have 90 the whole content on line B.

To Gauge a Rhombus.

Definition.

A RHOMBUS is a figure having four equal ſides, and the oppoſite Angles equal, but not right.

Problem VII.

The ſide *b e* and perpendicular *a c*, falling from the obtuſe Angle given, to find the Area.

Rule.

Multiply *b e* by *a c*, the Product is the Area in Inches, which divided by 217.6 or multiplied by .0046, gives the Area in Gallons; and that Area multiplied by the depth, gives the whole content.

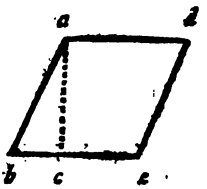
Example.

Suppoſe *b e* = 50 and *a c* = 48 Inches.

a c = 48

400
200

Area in Inches 2400



217.6) 2400.000 (11.02 Area in Gallons.
2240
6400
2048

11.02 Area in Gallons.
12 Depth.

2204
1102

132.24 the whole content.

Now

Now by the Slide.

Set 50 upon line B, to 217.6 upon line A, then under 48 on line A, you have 11 the Area in Gallons on line B.

Then set the Area 11 upon line B, to Unit or 1 on line A, and under 12 the depth on line A, you have 132 the whole content on line B.

To Gauge a Rhomboides.

Definition.

A RHOMBOIDES is a four sided figure, whose oppoſite ſides and angles are equal; but hath no right angles.

Problem. VIII.

The ſide *e b* of a Rhomboides, and *df* from the obtuſe angle given, to find the Area.

Rule.

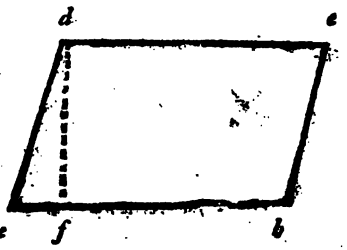
Multiply *e b* by *df*, the Product is the Area in Inches: which divided by 217.6 or multiplied by .0046 gives the Area in Gallons; which multiplied by the depth, gives the whole content.

Example.

Suppoſe *e b* = 112 } Inches.
df = 48 }

896
448

Area —— 5376 in Inches.



217.6) 5376.000 (24.70 Area in Gallons.
10240
15360
1280

 24.70

24.70 Area in Gallons.
6.5 Depth.

12350
14820

160.550 the whole content.

Now by the Sliding Rule.

Set 112 on line B, to 217.6 on line A, then under 48 on line A, you have 24.7 on line B, which is the Area in Gallons.

Then set 24.7 the Area on line B, to Unit or 1 on line A, and under 6.5 the Depth on line A, you have 160.5 the whole content on line B.

To Gauge a Trapezium.

Definition.

A TRAPEZIUM is a quadrangular Figure, whose sides and Angles are all unequal.

Problem IX.

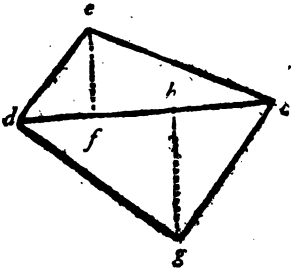
The Diagonal *c d*, and the perpendiculars *e f* and *g h*, of a Trapezium being given, to find the Area.

Rule.

Multiply half *c d*, by the sum of *e f* and *g h*, the Product is the Area in Inches, which divided by 217.6, or multiplied by .0046, gives the Area in Gallons; and that multiplied by the Depth, gives the whole Content.

Example.

Suppose *c d* = 114
e f = 56
g h = 38
} Inches.



½ *c d* —— 57
e f and *g h* 94

228
513

Area — 5358 *in Inches.* 217.6

217.6) 5358.090 (24.02 Area in Gallons.
1c060
13560
5040
688

24.02 Area in Gallons.
9.5 Depth.

12010
21618

228.190 The whole Content.

Note, That all other irregular right lined figures, consisting of more than four unequal sides, must be divided into Triangles, and the Areas of them being found, as I have shewed in Problem IV. and added together, will be equal to the Area of the whole figure.

Now the above Problem by the Slide.

Set 57 on the line B, to 217.6 on line A, then under 94 on line A, you have 24 the Area in Gallons.

Then set 24 the Area on line B, to Unit or 1 on line A; and under 9.5 the depth on line A, you have 228.1 the whole content on line B.

To Gauge Regular Polygons.

Definition.

ALL regular Polygons have equal Sides and Angles, and derive their denomination from the number of Angles; (as a figure of five equal Angles is called a Pentagon, of six Angles a Hexagon, &c.)

Problem X.

The side *d b*, and perpendicular *c a* of a Pentagon given, to find the Area.

Each

Rule.

Multiply half the sum of the sides of any regular Polygon, by the perpendicular or neareſt diſtance from the centre to one of the ſides, the Product is the Area in Inches; which divided by 217.6, or multiplied by .0046, gives the Area in Gallons; and that multiplied by the Depth, gives the whole content.

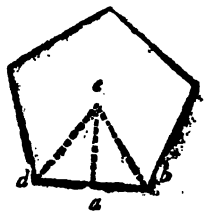
Example.

Suppoſe $d\,b$ = 50, and $c\,a$ = 34.41 Inches.

50

Sum of the ſides —— 250
½ Sum — — 125
$c\,a$ — — — 34.41

125
500
500
375



Area — — 4301.25 in Inches.

217.6) 4301.250 (19.76 Area in Gallons.
21252
16685
14530

1474

A Table of fixed Multiplicators for finding the Areas in Inches and Gallons of the first ten regular Polygons.

A	The Side 1.	Multiplicators for	
		Inches.	Gallons.
3	Trigon - - - - -	0.433013	.001989
4	Tetragon - - - -	1.000000	.004595
5	Pentagon - - - -	1.720478	.007906
6	Hexagon - - - -	2.598090	.011888
7	Heptagon - - -	3.633931	.016700
8	Octagon - - - -	4.828428	.022191
9	Eneagon - - - -	6.180000	.028400
10	Decagon - - - -	7.695833	.035366
11	Hendecagon - -	9.372916	.043074
12	Dodecagon - - -	11.196000	.051451

Problem XI.

The side *d b* of the Pentagon, (which is meant by the laſt figure) being given to find the Area.

Rule.

Multiply the Square of *d b*, by the Multiplicator for a Pentagon, the Product is the Area required.

Example.

Suppoſe *d b* = 50 Inches,

50

Squared 2500

Multiplicator for Inches 1.720478

d b ſquared — 2500

860239000

3440956

Area in Inches — 4301.195000

Mul-

Multiplicator for Gallons ——	.007906
d b ſquared —	2500
	3953000
	15812
Area in Gallons — — — —	19.765000 —as in pro. X.

Now by the Slide.

Note, Let the ſide of a Pentagon, as in the laſt figure, be 50 Inches, the ſquare of 50 is 2500, this multiplied by its proper Multiplicator, *viz.* .007906, the product is 19.765, which is the Area in Gallons: The like may be done for any other; but the Area is better found by the Rule, thus:

Set 1 upon D, to the proper number taken out of the Table upon C; then againſt the ſide upon D, you have the Area upon C; and the contrary. In the Example above the Pentagon's ſide was 50.

Now ſet 1 upon D, to .007906 upon C, then againſt 50 upon D, is 19 765 upon C, the Area ſought.

And without moving the Rule, you have the Area of all Pentagons in Gallons; for againſt the ſide upon D, is the Area upon C; ſo if the ſide be 71, the Area will be 40 Gallons.

To Gauge the Sector of a Circle.

Definition.

THE Sector of a Circle, is a figure made by two Radius's (or Semidiameters) and part of the circumference.

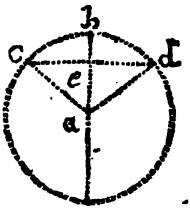
Problem XII.

The Semidiameter *a c*, and arch-line *c b d* of the Sector of a Circle given, to find the Area.

Rule.

Multiply *a c* by *c b* (half the arch-line) the Product is the Area in Inches, which divided by 217.6, or multiplied by .0046, gives the Area in Gallons, and that multiplied by the Depth, gives the whole content.

Example.



Example,

Suppoſe $a\ c = 15$, and $c\ b = b\ d$ 12.614 Inches,

$a\ c = 15$

63070
12614

217,6) 189.210 (.869—Area in
15130 (Gallons.
20740
1156

Of the Segment of a Circle.

Definition.

A SEGMENT of a Circle, is a figure contained between one right line (called the Chord) and any part of the circumference, either greater or leſs than a Semicircle.

Problem XIII.

The Chord $c\ d$, $e\ a$, the complement of the verſed Sine to Radius, and the Area of the Sector $a\ c\ b\ d$, (as in the figure above given, to find the Area of the Segment $c\ d\ b$.

Rule.

Multiply $c\ d$ by half $e\ a$, and deduct the Product out of the Area given, the remainder is the Area of the Segment in Inches, which divided by 217.6, or multiplied by .0046, gives the Area in Gallons.

Example.

Suppoſe —— $e\,d = 22.36$
$e\,a = 10$
Area of the Sector $a\,c\,b\,d = 189.21$ } Inches.

$c\,d = 22.36$
$\frac{1}{2}\,e\,a = 5$

Area of the Triangle — 111.80
Area of the Sector $a\,c\,b\,d$ 189.21
Area of the Triangle $a\,c\,d$ 111.80

Area of the Segment $c\,b\,d$ — 77.41

217.6) 77.4100 (.355 Area in Gallons.
12130
12500
1620

THE GAUGING OF SOLIDS.

Of a Prism.

Definition.

A PRISM is a ſolid figure comprehended under ſeveral Planes, two of which being oppoſite, are called the Baſes, and are equal, parallel, alike and alike ſituate; all the other Planes are Parallelograms, in which a right line may be every where applied between both the Baſes (which may be a Trigon, Tetragon, Pentagon, or any other plain ſuperficies.)

(Under this name Priſm, or Definition) is comprehended that ſolid of two circular Baſes, commonly called a Cylinder, which is generated by the revolution of a right angled Parallelogram on one of its ſides.

Problem XIV.

The Area of the Baſe of a Priſm, and the perpendicular Altitude being given, to find the ſolid content.

Rule.

Multiply the Area of the Baſe of any Priſm, by the perpendicular Altitude, (or neareſt diſtance from one Baſe to the other) the Product is the content required.

Example.

Example. 1st.

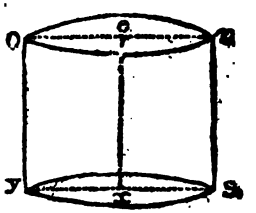
Suppoſe the Area of a triangular Priſm, as in Problem IV, to be 12.86 Gallons.

	12.86	Area in Gallons.
Perpendicular —	12	Inches.
	2572	
	1286	
Content in Gallons	154.32	

Example. 2d.

Suppoſe the Area of a Cylinder to be —	3.248	Gallons.
Altitude — —	36	Inches.
	1.9488	
	9744	
Content in Gallons — —	116.928	

Now I will ſhew the figure (as we will ſuppoſe) that will repreſent a Brewer's Tun, and that in the form of a round Priſm or Cylinder, and tell its content by the Slide.



Let this figure be called a round Tun, whoſe Diameter at top, *viz.* *(o n)* at the bottom, each being 120 Inches; and the Altitude *(e x)* 36 Inches; what is the content in Gallons and Barrels?

Set 36 the Tun's Depth upon C, to the Gauge-point upon D, then under 120 the Diameter upon D, you have 1871.42 in Gallons; which ſum divided by 32, quotes 58.482 the Barrels in ſaid Tun.

Obſerve well thoſe three things, *viz.*

1st, By the Depth and Content to find the Diameter; ſuppoſe the Depth 30 Inches, and the Content 15 Ale-Barrels what is the Diameter?

Set 30 the Depth upon C, to the Gauge-point for a Barrel, (*viz.* 94.15) upon line D, then over 15 the Content upon line C, you have 66.6 Inches the Diameter on line D.

2d, By the Diameter and content to find the Depth; without moving the Rule, ſay,

As 66 6 the Diameter, is to 15 the content,

So is the Gauge-Point, to 30 the Depth.

3d, By the Depth and Diameter to find the content: The Rule ſtanding as before, ſay,

As the Gauge-point, is to 30 the Depth,

So is 66.6 the Diameter, to 15 the content.

Here are three Queſtions reſolved by once ſetting the Rule.

To Gauge a Pyramid.

Definition.

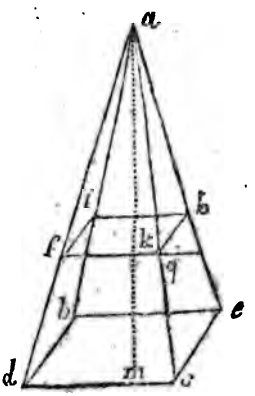
A PYRAMID is a ſolid figure, contained under ſeveral Planes ſet upon one right lined Baſe, from whence it decreaſeth equally, till it meet in a point at the top, which is called the Vertex; in each of thoſe Plaues a right line may be every where applied from the Baſe to the Vertex.

Problem XV.

Given *d e*, the ſide at the Baſe of a ſquare Pyramid, and *a m*, the perpendicular from the Baſe to the Vertex, to find the ſolid content.

The Rule.

Multiply the Area of the Baſe of any Pyramid, (whether it be Triangular, Quadrangular, Pentagonal, &c.) by ⅓ of the perpendicular Altitude, the Product is the ſolid content.



Example.

☞ *Note*, That under this name Pyramid is comprehended that pyramidical body (whoſe Baſe is a Circle) commonly called a Cone, and a Pyramid is one third part of a Priſm, therefore this is univerſal for all Pyramids, in whatever form their Baſes be; and the content thus found, will be Inches, Gallons, Barrels, &c.

Suppoſe

Suppoſe $d\,c = 50$, $a\,m = 48$ } Inches.

Area of the Baſe — —	11.48	Gallons.
$\frac{1}{3}$ of the Perpendicular $a\,m$	16	Inches.
	6888	
	1148	
Content in Gallons —	183.68	

Now by the Slide.

Set 50, (which is the ſide of the Baſe) on line B, to 217.6 on line A, then under 48 the perpendicular upon line A, you have 11.4 the Area in Gallons.

Then ſet 11.4 the Area ſo found, on line B, to Unit or 1 on line A, then under $16\frac{1}{3}$ of the perpendicular on line A, you have 183 the content in Gallons on line B.

Which ſum divided by 32, quotes the content in Barrels.

Or the Barrels may be found by the Gauge-point (94.15) on line D.

Of the Fruſtum of a Pyramid.

Problem XVI.

GIVEN, $d\,c$, the ſide of the greater Baſe (ſee the laſt figure) $f\,q$, the ſide of the leſſer Baſe, and $k\,m$, the Altitude of the Fruſtum of a Pyramid, to find the ſolid content.

Rule.

Multiply the Areas of both Baſes, and a geometrical mean between them, by $\frac{1}{3}$ of the Altitude, the Product is the ſolid content.

Note, As there may be ſome who do not know how to find a geometrical mean, (let ſuch, if any there be, that reads this Book) take theſe Notes, *viz.*

First by the Pen.

Let the Number given be 50 and 72.

Multiply one Number by the other, then extract the Square-Root of the Product, (which I have carefully ſhewn juſt before Gauging) this Square-Root is the geometrical mean between the

the two Numbers given; for 72 multiplied by 50, is 3600, whose Square-Root is 60, the geometrical mean between 50 and 72.

Or it may be found by the Slide, thus:

Set 50 upon line C, to 50 upon line D, then over 72 upon C, you have 60 upon line D, which is the mean sought; and so of any other Numbers: But as this is a digression, I shall return to what I began, viz. to measure the above Frustum of a Pyramid.

An Example from the foregoing Problem.

Suppose —— $d\,c = 50$, $f\,q = 25$, and $k\,m = 24$ Inches.

	50	25	
Area of the greater base	2500	125	
		50	
Area of the lesser Base —		625	
		2500	
		312500	
		1250	
		1562500	(1250 geometrical mean.
	22—56		
	245—1225		
Area of the greater Base — $d\,b\,e\,c$ =		2500	} Inches.
Area of the lesser Base — $f\,i\,b\,q$ =		625	
Geometrical Mean — —		1250	
	Sum —	4375	
⅓ of $k\,m$ the Altitude — —		8	
Solidity in Inches — —		35000	

217.6) 35000.000 (160.84 Content in Gallons.
13240
18400
9920
1216

Or thus.

To the Area correſpondent to the Semi-Sum of the given ſides, add a third part of the Area of the Semi-difference, the Sum is a mean Area, which multiplied by the Altitude, gives the ſolid content.

	$dc = 50$		$de = 50$
	$fg = 25$		$fg = 25$
Sum --	75	Difference	25
Semi-Sum --	37.5	Semi-differ.	12.5
	37.5		12.5
	1875		625
	2625		250
	1125		125
Area --	1406.25		156.25 Area.
	52.084		$\frac{1}{3}$ -- 52.084
Mean Area	1458.334		
Altitude $k\,m$	24		
	5833336		
	2916668		
Solidity --	35000.016 Inches.		

217.6) 35000.016 (160.84 Content in Gallons as before.
13240...
18401
9936
1232

☞ To find an arithmetical mean. Note, it is half the ſum of any two numbers added together; as of (60) and (40) the mean is the half, viz. (50) and this mean is always greater than the geometrical mean; as in the above numbers (72) and (50) the arithmetical mean is (61) and the geometrical mean but (60) as above.

Of

Of a Cone.

Definition.

A CONE (or round Pyramid) is a ſolid figure, made by the revolution of a right-angled plain Triangle, upon one of the ſides containing the right angle, which ſide is called the Axis or Perpendicular.

Problem XVII.

Given *b d*, the Diameter at the Baſe, and *c a*, the (Axis or Perpendicular from the Baſe to the Vertex) to find the ſolid content.

Rule.

Multiply the Area of the Baſe by $\frac{1}{3}$ of the Altitude, and the Product is the ſolid content.

Suppoſe *d b* = 50 and *a c* = 48 Inches.

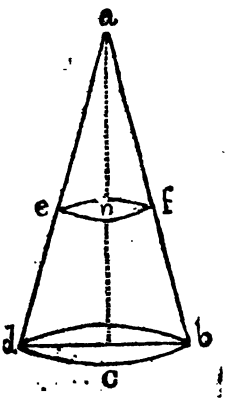
50

277.05) 2500.0000 (9.02 Area in Gallons.
065500
10090

Area in Gallons — 9.02
$\frac{1}{3}$ of the Altitude *c a* 16

5412
902

Content in Gallons 144.32



By the Slide.

Set Unit or 1 upon line C, to the Gauge-point on line D, and under 50 on line D, you have 9 the Area in Gallons on line B.

Then ſet 9 the Area ſo found on line B, to Unit or 1 upon line A, and under 16, $\frac{1}{3}$ of the Altitude on line A you have 144.3 on line B, the whole content.

Of

Problem XVIII.

Of a Sphere or Globe.

A GLOBE or Sphere, is a round ſolid body like a bullet; and its content is thus found.

Rule.

Multiply the Diameter by itſelf (or Cube the Globe's Diameter) and that Product again by the ſame Diameter, that laſt Product multiplied by (11) and the Product divided by (21) the Quotient is the ſolid content of the Globe in Inches; and laſtly, if the Cube of the Diameter (of any Globe) be multiplied by .002407, the Product is the content in Gallons; and the ſame, if divided by 217.6.

Example.

12
12

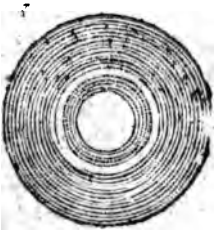
24
12

144
12

288
144

1728
11

1728
1728



21) 19008 (905 The ſolid content in ſquare Inches.

The laſt given Cube — 1728
The Multiplicator — .002407

12096
6912
3456

Gallons — 4.159296

Of a Priſmoid.

Definition.

A PRISMOID is a ſolid figure contained under divers Planes, two whereof being oppoſite all called the Baſes, which are to be Rectangular, Parallel, and alike ſituate, in either, of the other Planes, a right line may be every where applied from one Baſe to another.

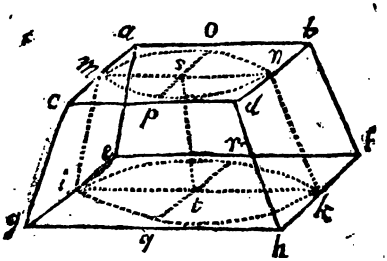
Problem XIX.

Given $g\,h$ the length, and $b\,f$ the breadth below, $c\,d$ the length, and $d\,b$ the breadth above, and $s\,t$ the Altitude, to find the content.

Rule.

To $g\,h$ add $\frac{1}{2}\,c\,d$, and multiply the ſum by $b\,f$,
To $c\,d$ add $\frac{1}{2}\,g\,h$, and multiply the ſum by $d\,b$,
The ſum of thoſe two products multiplied by $\frac{1}{3}$ of $s\,t$ the Altitude, and this laſt Product divided by 217.6, or multiplied by .0046, gives the content in Gallons.

Example.



	Length.	*Breadth.*	
Suppoſe — $g\,h$	= 120	$b\,f$ = 80 below	Altitude $s\,t$ = 24
$c\,d$	= 90	$d\,b$ = 70 above	Inches.

$g\,h$

$g\,b$ — 120	$e\,d$ — 90	
$\frac{1}{2}\,c\,d$ — 45	$\frac{1}{2}\,g\,b$ — 60	
165	150	
$b\,f$ — 80	$d\,b$ — 70	
13200	10500	
	13200	
	23700	
	$\frac{1}{3}$ of $s\,t$ ——— 8	
217.6)	189600.00	(871.3 Content in Gallons.
	15520	
	2880	
	7040	
	512	

Here you may plainly ſee the whole is anſwerable to all its parts taken together, (Axiom 19th, 1ſt Euclid.)

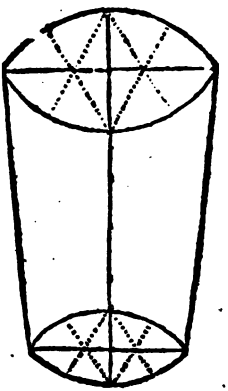
Note, That by the foregoing rule the content of any Tun may be found, whoſe parallel Baſes are Rectangular Parallelograms, or Ellipſis and the ſide ſtraight; whether the Baſes are alike or unlike, proportional or diſproportional, alike ſituate or inverted.

To Inch and Tabulate a Brewer's Tun, in the form of a Cylindroid.

WHEREAS moſt common Brewer's Tuns, for the conveniency of cleanſing, do lean or decline from a true horizontal Plane; inſomuch that when the bottom on one ſide is but juſt covered, there ſhall be three or four Inches of liquor on the other ſide; in ſuch caſes the ſureſt way is to pour in by ſome known meaſure ſo much liquor as will juſt cover the bottom, and from the ſurface thereof proceed to take your tranſverſe and conjugate Diameters in the middle of every ſix Inches; from which you are to Inch and Tabu-

late according to the Cylindrical Tun hereunto annexed, and may indifferently ſerve for a Priſmoid as well as a Cylindroid.

Note alſo, That it may be properly applied to that of a Copper, with this difference, that when you have found the content of the Crown (which is beſt done by pouring as much Liquor out of ſome known meaſure as will juſt cover it) then from the top or ſurface thereof proceed to take your Dimenſions in the middle of every ſix Inches of the Perpendicular Altitude of the Copper, and from thence proceed to Inch and Tabulate as above.



To make this more eaſy and plain multiply the tranſverſe and conjugate Diameters together, and the Product multiply by .00361, or divide by 277 for a Cylindroid, or multiply by .0046, or divide by 217.6 for a Priſmoid, gives the Area. After the ſame manner find the Areas of the other ſections, or every 6 Inches, then multiply the firſt found Area by 9 tenths, the parts wanting to make up the 5th Inch in the oppoſite Tun; and to the Product add the liquor meaſured in, the total is the true content of the 5th Inch; then add to this laſt found content the whole Area, that produces the content of the *6th* Inch. After the ſame manner the content of each Inch of the Tun's Altitude is found; only obſerve to make uſe of the proper Areas belonging to each Section. *See the Work.*

A Brewer's

A Brewer's Tun the form of a Cylindroid, Inched and Tabulated.

Inches.	Content.	Areas.
4.1	139 10	Meafured
5	188.03	in
6	242.40	
7	296.77	
8	351.14	54.37
9	405.51	
10	459.88	
11	513.95	
12	568.02	
13	622.09	
14	676.16	54.07
15	730.23	
16	784.30	
17	837.99	
18	891.68	
19	945.37	
20	999.06	53.69
21	1052.75	
22	1106.44	
23	1159.75	
24	1213.06	
25	1266.37	
26	1319.68	53.31
27	1372.99	
28	1426.30	
29	1479.27	
30	1532.24	
31	1585.21	
32	1638.18	52.97
33	1691.15	
34	1744.12	

Tun's Altitude at the dipping place, — 58.5

Dimenſions taken in the middle of every ſix Inches.

Tranſvers.	Conjugate.	Area.
6—132.0—	114.1—	54.37
6—131.5—	113.9—	54.07
6—130.7—	113.8—	53.69
6—130.0—	113.6—	53.31
6—129.3—	113.5—	52.97

132 { Transverse } Multiplied together.
114.1 { Conjugate }

132
528
132
132

150612
.00361

150612
903672
451836

54.370932 Area of the first Section.
.9 Parts wanting to make up the fifth Inch.

48933
139 10 Liquor measured in.

188.033 Content of the fifth Inch.
54.37 The Area added to the last Content, gives —

242.40 The content of the sixth Inch.

After the same manner the several contents of each Inch of the Tun's Altitude are found; only observe to make use of the proper Areas belonging to each Section.

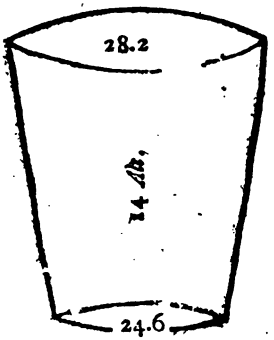
Note, Before you begin to take your Dimensions, you must quarter your Tun, *viz.* with your long Sliding Rule, take the greatest length at the bottom, and the greatest breadth, marking with chalk at each point, then let fall a perpendicular at each point, and draw a direct line from thence to the top, observing an exact distance between each point, and mark your stations for taking your Dimensions from the surface of the liquor, in the middle of every six Inches, as directed in the rule above.

To

To Gauge a Braſs Pan.

Problem XXIV.

SUPPOSE the equated Diameter of a Pan, at the top of the Liquor be 28.2, and the bottom 24.6, the depth 14 Inches; I demand the content in Gallons?



Rule.

When a Pan is no true Circle, but rather Elliptical, take the Diameter at the top and bottom, theſe added together, half the ſum is a Diameter for that end; and in like manner find a Diameter for the other end, (thoſe two Diameters added together) half the ſum is a mean for the whole.

Then find the Area of that laſt mean Diameter, and that Area multiplied by the depth of the Pan, (taken between the middle of the Pan and ſide) gives the content in Gallons.

Example.

Example.

To	--	28.2
Add	--	24.6
Sum	--	52.8
½ Sum	--	26.4 Mean Diameter.
	2.516	Area.
	14	Depth.
	10064.	
	2516	
Content	35.224	in Gallons.

To Gauge a Segment of a Globe.

Problem XXV.

Definition.

A SEGMENT of a GLOBE is a figure contained between one right line called the Chord and any part of the Circumference, either greater or leſs than a Semi-Circle.

Rule.

Find the Area of the Chord Line, that is, (ſquare it) then multiply that ſquared ſum by 00361, the Product is the Area which Area multiplied by ¼ of the Altitude, gives in the Product the content in Gallons.

Example.

Chord Line -- 27.6
Altitude -- 9.2 } Inches.

27.6

27.6
27.6

1656
1932
552

761.76 Squared Sum.
.00361

76176
457056
228528

Area —2.749|9536
4.6 ½ the Altitude.

16494
10996

The content — 12.6454 in Gallons.

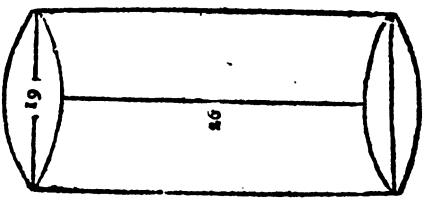
TO GAUGE A CYLINDER.

Problem XXVI.

Rule.

FIRST ſquare the Diameter of the Cylinder's Baſe, and that ſquared ſum multiplied by .00361, gives the Area or content of the Cylinder upon one inch deep in Gallons and parts.

Then this Area ſo found multiplied by the length, gives in the Product the whole content in Gallons.



Example.

19
19
171
19
361
.00361
361
2166
1083

Area — — 1.303|21 upon one Inch deep.

Area — 1.303 in Gallons.
26 depth.

7818
2606

Content 33.878 in Galls.

Now by the Sliding Rule.

Set Unit or 1 upon line C, to the Gauge-point on line D, then under 19 on line D, you have 1.3 the Area on line C.

Next, place 26 the depth on line C, to the Gauge-point on line D, and under 19 on line D, you have 33.8 the content on line C, which agrees with the pen as above.

TO GAUGE A SHIP.

The Rule.

MULTIPLY the length of the Keel, by the breadth at the Midſhip-beam, and the Product by the depth of the Hold; then divide this laſt Product by 100, the Quotient is the Ship's burthen in Tuns (if a King's Ship) but in Merchant Ships, where there is no allowance for Ordnance, Maſts, Sails, Cables or Anchors, divide the laſt Product by 94, and the Quotient is the Ship's burthen.

Note, Everard bids you divide by 95.

☞ Obſerve, if you take half the breadth for the depth, and work as above, it will give the Tunnage.

Example.

Suppoſe { The length of the Keel — 50.5 / Breadth of the Midſhip-beam — 20 / Depth of the Hold — — 10 } Feet.

50.5
20

1010.0
10 Tuns.

100) 1010.00 (101 Burthen of a King's Ship.

Tuns.

94) 1010.00 (107.4 Burthen of a Merchant Ship.
700..
420

44

Note, That for the more ready finding the burthen of any Ship, the dimenſions ſhould be taken in feet and decimal parts of a foot; but in regard that the Feet upon moſt rules are divided into Inches, and not decimally, I have here inſerted Decimal fractions equal in value to any number of Inches under a Foot.

Inches.				*Decimals.*
1	—	—	—	.0834
2	—	—	—	.1666
3	—	—	—	.25
4	—	—	—	.3334
5	—	—	—	.4166
6	—	—	—	5.
7	—	—	—	.5834
8	—	—	—	.6666
9	—	—	—	.75
10	—	—	—	.8334
11	—	—	—	.9166

The deſcription and uſe of the Gauging-rod, or four Feet rule, in Gauging of Caſks, &c.

FROM the end not bevelled, on one ſide is a line of Inches, running from 1 to 48, each Inch being divided into tenths: adjoining to this is another line, (if your rule be cut right after the Engliſh method) which gives the Area of any Circle in Ale-

Ale-Gallons, and hundredth part of a Gallon, upon one Inch deep, having the Diameter in Inches and tenths of an Inch; on this line is wrote the Area in Gallons, and is called Oughtread's line.

Upon another ſide of the rule is a Diagonal for Ale Gallons, by which is ſhewn the number of Ale Gallons any caſk contains; the method is thus: put the bevelled end of the rule in at the Bung hole, and run it down to the head diagonalwiſe, then the number on the line againſt the middle of the Bung, is the content of the Caſk in Ale Gallons.

Note, Care muſt be taken that the Bung hole be in the middle of the Caſk, and that the rule be put to the middle of the Bung hole.

And you may have on a third ſide of your rod an Ullage line cut, and the method is thus: cauſe a caſk to be filled with water, and then draw out the Liquor, Gallon by Gallon, and ſo mark your rule, as the Liquor ſinks in the veſſel.

And when you have your rule cut according to this method, to find the number of Gallons in the Caſk, proceed thus:

Put the bevelled end of your rule down into the Bung hole to the oppoſite ſtave of the Caſk, and ſo far as the rule is wet, on the proper line for the veſſel, (for Note that you muſt cut two lines after the above method, one for ſmall veſſels that bulge but little, as Barrels; and another for thoſe of greater bulges, as butts, &c.) ſo many Gallons are in the veſſel.

Then the number from the inſide of the Bung hole to the ſurface of the Liquor, ſhews how many Gallons will fill the veſſel.

Note, The above diagonal line will ſerve very well for any veſſel under 40 Gallons.

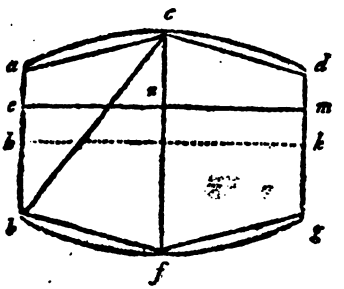
GAUGING OF CLOSE CASKS.

OF cloſe Caſks there may be various forms, but thoſe that are moſt commonly uſed, may be conſidered under theſe four denominations, *viz.*

1. The

1. The Middle Fruſtum of a Spheroid.
2. The Middle Fruſtum of a Parabolick Spindle.
3. The Middle Fruſtum of an Hyperbolick Spindle.
4. The Middle Fruſtum of two Cones abutting upon one common baſe.

The firſt and laſt of theſe ſolids are deſcribed by Problem 27 and 30, in which though the length and diameters at Bung and Head are the ſame, yet it is very diſcernable, that the content of one is more than the content of the other; and that there may be other caſks of the ſame dimenſions, whoſe ſtaves have not ſo much curviture as thoſe of a Spheroid, and yet are not ſo ſtraight as thoſe of the Middle-Fruſtum of two Cones, and conſequently containing leſs than the one, and more than the other; which is plain from the occult line drawn between both in this figure.



Let us therefore ſuppoſe four Caſks of the ſame dimenſions, diſtinguiſhed by the above demominations, *viz.*

The firſt having ſtaves of the greateſt curviture,
The ſecond leſs,
The third not ſo much as either,
The fourth having ſtraight ſtaves from the Bung to the Head.

Each of which caſks may be gauged exactly by the following Rules. And obſerve this: to the ſum and half ſum of the ſquares of the Head and Bung diameters, add half the difference of the ſaid ſquares, and the ſum of thoſe multiplied by the length, and this Product.

Multiplied or Divided } By { .001203 / 831.15 } Gives the content in Gallons. (Iriſh Meaſure.)

Alſo

Alſo each of thoſe Caſks (having found a mean) may be gauged by the Sliding-rule; for,

As the Gauge-point is to the Caſk's length,

So is the mean Diameter to the content.

Note, I have in the next Problem given a table, by which having the Head and Bung, the mean Diameter of any Caſk may be readily found; and then in all caſes, the Rule is,

Set the length to the Gauge-point, and under the mean Diameter you have the content.

To Gauge the Middle Fruſtum of a Spheroid.

Problem XXVII.

THE Bung and Head Diameters being given, and the length, to find the content of a Caſk taken as the Middle Fruſtum of a Spheroid, intercepted between two parallel planes, cutting the Axis at right angles.

Rule.

To the ſum and half ſum of the ſquares of the Bung and Head Diameters (as before directed under the laſt figure) and half the difference of the ſaid ſquares, the ſum of thoſe multiplied by the length, and this product divided by 831.15, or multiplied by .001203, gives the content in Gallons.

Or thus.

Multiply the difference of the Bung and Head Diameters by 7 tenths, and the Product added to the Head Diameter, is a mean Diameter, the ſquare whereof being multiplied by .00361, and this Product by the length, gives the content in Gallons.

A Table

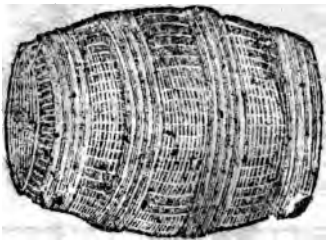
A Table to reduce a Spheroid to a Cylinder.

Difference	No to be add'd	Difference.	No. to be add'd	Difference.	No. to be add'd
(1)	0.7	(5.)	3.5	(9.)	6.3
.2	0.8	.2	3.6	.2	6.4
.4	0.9	.4	3.7	.4	6.5
.6	1.1	.6	3.9	.6	6.7
.8	1.2	.8	4.0	.8	6.8
(2.)	1.4	(6.)	4.2	(10.)	7.0
.2	1.5	.2	4.3	.2	7.1
.4	1.6	.4	4.4	.4	7.2
.6	1.8	.6	4.6	.6	7.4
.8	1.9	.8	4.7	.8	7.5
(3.)	2.1	(7.)	4.9		
.2	2.2	.2	5.0		
.4	2.3	.4	5.1		
.6	2.5	.6	5.3		
.8	2.6	.8	5.4		
(4.)	2.8	(8.)	5.6		
.2	2.9	.2	5.7		
.4	3.0	.4	5.8		
.6	3.2	.6	6.0		
.8	3.3	.8	6.1		

☞ *Note*, In Caſks whoſe ſtaves are riſing at the Bung, you muſt find the difference betwixt Head and Bung Diameter, and with that difference enter the above table, againſt which difference in the firſt column, you will find a number in the ſecond which added to the leſſer Diameter will make a mean between Head and Bung.

Example.

Example.



Suppose the Diameter at { Bung = 28 / Head = 18 } Length — 36.

Difference — —		10
		7
		7.0
Head — — —		18
Mean Diameter —		25
		25
		125
		50
Squared — —		625
		.00361
		625
		3750
		1875
Mean Area —		2.25625
Length — —		36
		1353750
		676875
Content — —		81.22500 in Gallons.

By the Sliding Rule thus.

Set Unit on line C, to the Gauge-point on line D, then under the Diameter 25 on line D, you have 2.2 the Area on line C: then,

Set 36 the length on line C, to the Gauge-point on line D, and under the Diameter 25 on line D, you have 81.2 the content of the Caſk on line C.

Problem XXVIII.

THE Bung and Head Diameters, and length of a Caſk being given, to find the content: if it be taken as the Middle Fruſtum of a Parabolic Spindle, intercepted between two planes, parallel, and cutting the Axis at right angles.

Rule.

To the ſum and half ſum of the ſquares of the Bung and Head Diameters, and $\frac{1}{10}$ of the difference of the ſaid ſquares, the ſum of theſe multiplied by the length, and this Product divided by 831.15, or multiplied by .001203, gives the content in Gallons.

Or thus.

Multiply the difference of the Diameters by .62, the Product added to the Head, is a mean Diameter, the ſquare whereof being multiplied by .00361, and this Product by the length, gives the content in Gallons.

Example.

Diameters { Bung = 28 / Head = 18 } Length 36, as before.

Difference = 10

Difference

Difference	—	10
		.62
		20
		60
		6.20
Head	—	18
Mean Diameter	—	24.2
		24.2
		484
		968
		484
Squared	—	585.64
		.00361
		58564
		351384
		175692
Mean Area	—	2.1141604
Length	—	36
		126849624
		63424812
Content		76.1097744 in Gallons.

You ſee though theſe dimenſions, and thoſe of the laſt figure, are the ſame, how they differ in the content.

Note, That in the place of thoſe 4 ſorts named, we may meet 400 ſorts, and out of that number not able to ſhew any two exactly of the ſame make; in ſuch caſes, experience is the beſt maſter.

Now by the Slide.

Set Unit on line C, to the Gauge-point on line D, then under 24.2 the mean Diameter on line D, you have 2.1 the Area on line C.

Next, ſet 36 the Caſk's length on line C, to the Gauge-point on line D, and under 24.2 the mean on line D, you have 76 the Caſk's content on line C.

Problem XXIX.

TO Gauge the Middle Fruſtum of an Hyperbolick Spindle, intercepted between two parallel Planes, cutting the Axis at right angles, Bung, Head, and length being given.

Rule.

To the ſum and half ſum of the ſquares of the Bung and Head Diameters, add $\frac{1}{10}$ of the difference of the ſaid ſquares, the ſum multiplied by the length, and this Product divided by 831.15, or multiplied by .001203, gives the content in Gallons.

Or thus.

Multiply the difference of the Diameters by .58, the Product added to the Head is a mean Diameter, the ſquare whereof being multiplied by .00361, and this Product by the length, gives the content in Gallons.

Example.

Diameters — { Bung = 28, Head = 18 } Length 36, as before.

Difference	—	10
		.58
		5.80
Head	—	18
Mean Diameter		23.8
		23.8
		1904
		714
		476
Squared	—	566.44
		.00361
		56644
		339864
		169932
Mean Area	—	2.0448484
Length	—	36
		122690904
		61345452
Content	—	73.6145424 in Gall.

By

By the Slide.

Set Unit on line C, to the Gauge-point on line D, and under 23.8 the Diameter on line D, you have 2.0 the Area on line C.

Then ſet 36 the length on line C, to the Gauge-point on line D, and under 23.8 on line D, you have 73.6 the content on line C.

Problem XXX.

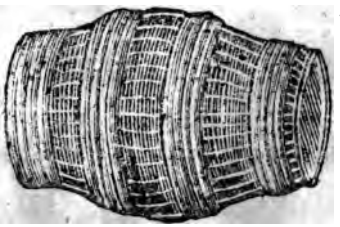
TO Gauge a Caſk, as the Middle Fruſtum of two Cones, abutting upon one common Baſe, the Bung, Head, and length being given.

Rule.

To the Area correſpondent to the ſemi-ſum of the given Diameters, add $\frac{1}{7}$ of the Area of the ſemi-difference, the ſum is a mean Area, which multiplied by the length, gives the content.

Or thus.

Multiply the difference of Diameters by .52, the Product added to the Head, is a mean Diameter; the ſquare whereof multiplied by .00361, and this Product by the length, gives the content in Gallons.



Example.

Diameters — { Bung = 28 / Head = 18 } Length 36, as before.

Difference — — 10

Differences

Difference — —		10
		.52
		20
		50
		5.20
Head — —		18
Mean Diameter —		23.2
		23.2
		464
		696
		464
Squared — —		538.24
		.00361
		53824
		322944
		161472
Mean Area —		1.9430464
Length —		36
		116582784
		58291392
Content —		69.9496704 in Gallons.

Now by the Sliding Rule.

Set Unit on line C, to the Gauge-point on line D, and under 23.2 the Diameter on line D, you have 1.9, the Area on line C.

Then set 36 the length on line C, to the Gauge point on line D, and under 23.2 the mean on line D, you have 69.9 the content on line C.

Problem

Problem XXXI.

TO find what Liquor remains in a Caſk part full, or what is drawn out, three things muſt be known before the ſegment can be found, *viz.*

The whole Content.
The Bung Diameter.
The Wet Inch.

Rule.

Divide the dry or wet Inch by the Bung Diameter, then look for the Quotient in the Segment Table, oppoſite to which is a Segment or Area, which multiplied by the Caſk's whole content, ſhews the quantity of Liquor remaining in the Caſk, or how many Gallons it wants to fill it.

Example for the Dry Part.

Let us ſuppoſe thoſe dimenſions, *viz.*

Whole Content	—	—	56	Gallons.
Bung Diameter	—	—	26	Inches.
Dry Part	—	—	7	Inches.

26) 7.00 (26 Quote.
52

180
156

24 Remainder.

Thus 26 being my Quote, I look in the Segment Table under Q, for this 26; but in this caſe I rather look for 27, (for you muſt always obſerve) that when you have divided, if your Remainder be more than half the Bung Diameter, (as above your Remainder is 24, more than half 26 your Bung Diameter) in this caſe, I ſay, you muſt take the next greater number, as I have here taken 27 inſtead of (26) and againſt 27 under Q, in the table, I find the Tabular Number or Area .2178.

.2178
Multiply by — 56 the whole content.

13068
10890

Ullage or Want 12.1968 Gallons.

Example

Example for the Wet Part.

26) 19.00 (73 Quote.
182

80
78

2 remainder.

The Tabular Number oppoſite 73 is .7822
Multiply by — 56 the whole content.

46932
39110

Remaining in the Caſk — — 43.8032 } Gallons.
Ullage or Want — — — 12.1968 }

Proof — — — — — 56.0000 Gallons.

See the Sliding Rule for the above ſupposed Cask, its Axis being parallel to the Horizon.

Set the Bung 26 on line C, to 100 on line D, then under 19 the wet Inch on line C, you will find 81 on the Segment line, (which 81 bear in mind.)

Next, ſet 56 the whole content on line B, to 100 on line A, then under 81 on line A, you have 45 Gallons (the Liquor remaining in the Caſk) on line B: which you ſee exceeds the above work by the table, 1 Gallon and 2 tenths.

☞ *Note*, The line of Segments on the Sliding Rule, was made for a Spheroid: and is therefore more exact for all bulging Caſks, than the table of Segments, which are proper only for a Cylinder. *See the demonſtration.*

The

THE SEGMENT TABLE.

Q.	Area.	Q.	Area.	Q.	Area.	Q.	Area.
1	.0017	99	.9983	26	.2066	74	.7934
2	.0048	98	.9952	27	.2178	73	.7822
3	.0087	97	.9913	28	.2292	72	.7708
4	.0134	96	.9866	29	.2407	71	.7593
5	.0187	95	.9813	30	.2523	70	.7477
6	.0245	94	.9755	31	.2640	69	.7360
7	.0308	93	.9692	32	.2759	68	7241
8	.0375	92	.9625	33	.2878	67	.7122
9	.0446	91	.9554	34	.2998	66	.7002
10	.0520	90	.9480	35	.3119	65	.6881
11	.0598	89	.9402	36	.3241	64	.6759
12	.0680	88	.9320	37	.3364	63	.6636
13	.0764	87	.9236	38	.3487	62	.6513
14	.0851	86	.9149	39	.3611	61	.6389
15	.0941	85	.9059	40	.3735	60	.6265
16	.1033	84	.8967	41	.3860	59	.6140
17	.1127	83	.8873	42	.3986	58	.6014
18	.1224	82	.8776	43	.4112	57	.5888
19	.1323	81	.8677	44	.4238	56	.5762
20	.1424	80	.8576	45	.4364	55	.5636
21	.1527	79	.8473	46	.4491	54	.5509
22	.1631	78	.8369	47	.4618	53	.5382
23	.1737	77	.8263	48	.4745	52	.5255
24	.1845	76	.8155	49	.4873	51	.5127
25	.1955	75	.8045	50	.5000	50	.5000

☞ *Note.* The Harmony of the Numbers in a Segment as in the oppoſite Work where the two remainders are always equal to the Bung-Diameter, and the two verſed Sines to 100, and the two Segments always equal to 10000: Alſo obſerve when you divide, if there be a remainder in either, above half the Diviſor, you muſt take the next greateſt tabular Number. And in all caſes on the Slide, the dry will be leſs, and the wet more than by the above Table.

An Example proving the Harmony.

24 2	The two Remainders.
26	Equal to the Bung-Diameter.
27 73	The two verſed Sines under the letter Q. for *Quotient*.
100	Equal to 100.
.2178 .7822	The two Segments, Areas, or tabular Numbers.
.10000	Equal to .10000. *See the foregoing Work.*

Problem XXXII.

TO find the Liquor remaining in a Caſk (ſuppoſe it the *Middle-Fruſtum* of a *Spheroid)* ſtanding upon one head, with its Axis perpendicular to the horizon.

Suppoſe Bung $e\ b=28$, Head $c\ d=18$, Length $m\ s=36$, Wet Inch $q\ f=27$. And the Caſk's whole content 81.2 Gallons.

Rule.

Divide the difference of the Areas $e\ b$ and $c\ d$, by the triple Square of $f\ s$, the Quotient multiplied by the Square of $q\ f$, and the Product deducted from the Area of $e\ b$, leaves the Area of a mean Circle, which multiplied by $q\ f$, produces the content of the *Fruſtum* $e\ b\ n\ l$, which being added to $e\ b\ d\ c$, the Semi-content, is the quantity of liquor remaining in the caſk.

Example.

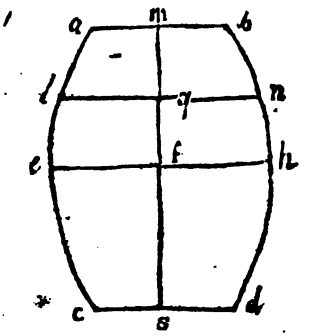
Area of $e\ b=2.830$, $c\ d=1.169$

$f\ s=18$	
18	
144	
18	
$f\ s$ ſquared — — —	324
3	
972	Triple

Triple-Square of $f s$=972) 1.661000 (.001708
6890..
8600
1708
824 . 13664
.138348

Area of $e h$ — — 2.83
The laſt Product — — 0.138348
2.691652
$q f$ — 9

Content of $l e b n$ — — 24.224868
Content of $e b d c$ — — 40.6 } Gallons.
Content of $l e d n$ — — 64.824868



To Gauge a Caſk ſtanding upon one End, full or part full.

The Rule.

IF the ſtanding Caſk be full, or more than half full, to the Diameter at the Superficies of the Liquor, add the Diameter of the bottom, and take half the Sum.

Subtract the half Sum from the Diameter at the Bung or wideſt place, and multiply the difference by ſeven Tenths,

and the Product added to the half Sum, gives a mean Diameter, for that Liquor; then multiply the Area of that mean Diameter in Gallons and parts, by the depth of the Liquor, and the Product is the content in Gallons.

Example.

The Bung Diameter	31	Inches.
The Top of the Liquor	30	
The Bottom Diameter	29	
Sum	59	
Bung Diameter	31	Subtract.
Half Sum	29.5	
	1.5	Difference.
	.7	
	1.05	Add.
Half Sum	29.5	
Mean Diameter	30.5	
Area in Gallons	3.358	
Depth	40	
The whole content	134.320	in Gallons.

If the Cask be not above half full, subtract the Bottom Diameter from the Diameter at the top of the Liquor, and multiply the difference by seven tenths, and the Product added to the Bottom Diameter, gives a mean Diameter of that Liquor; then work as before.

The Use of the following Table.

AS it often happens, that you can't take the Bung Diameter, the Cask standing upon one end, as either it has no Bung-hole, or if it has, may be prejudiced by taking it (as full) in such cases, girt the Cask in the Bung-place, and in the head, and having the circumference, find the mean Diameter arithmetically:

arithmetically: But as a help to thoſe who are not ſkilled in the common rules, and an eaſe to ſuch as are, I have here given a Table of Circumferences, anſwering to the Diameters in Inches and two Tenths, from one to ſixty Inches; in which Table firſt find the Circumference (as above directed) and on the left hand thereof you have the Diameter, then allowing for the thickneſs of the Staves according to Diſcretion, which is ſeldom above two, or under one Inch; and having the length, you may find the content by the Table of Cylinders as uſual.

Example.

Suppoſe the Caſk being girt at the middle, I find the circumference to be 90.5, on the left of it in the Table I find 28.8; then allowing 1.8 Inch for the thickness of the Wood, ſuppoſing the Staves 0.9 of an Inch thick, (I have then 27 for my inſide Bung Diameter) with which and the length, ſuppoſe (30) I enter the Table of Cylinders, and there find the content 78.93 Gallons, which I reſerve.

Next I girt the head, and find by the Table, after the proper allowance (as above) that there is 10 Inches difference betwixt the Diameters; with which difference alſo, and the 3d part of the length *viz.* 10, I enter the Table of Cylinders, and find there 3.61 Gallons; which added to the above Gallons reſerved, gives 82 Gallons and 5 Tenths the whole content. And ſo of any other.

See the Table.

A Table

A Table of Circumferences anſwering to Diameters,

Diam.	*Circumf.*	*Diam.*	*Circumf.*	*Diam.*	*Circumf.*
(1)	6.1	(7)	22.0	(13)	40.8
.2	3.8	.2	22.6	.2	41.4
.4	4.4	.4	23.2	.4	42.0
.6	5.0	.6	23.8	.6	42.7
.8	5.6	.8	24.5	.8	43.3
(2)	6.3	(8)	25.1	(14)	44 0
.2	7.0	.2	25.8	.2	44.6
.4	7.5	.4	26.4	.4	45.2
.6	8.2	.6	27.0	.6	45.8
.8	8.8	.8	27.6	.8	46.5
(3)	9.4	(9)	28.3	(15)	47.1
.2	10.0	.2	28.9	.2	47.7
.4	10.7	.4	29.5	.4	48.4
.6	11.3	.6	30.1	.6	49.0
.8	12.0	.8	30.8	.8	49.6
(4)	12.6	(10)	31.4	(16)	50.2
.2	13.2	.2	32.0	.2	50.9
.4	13.8	.4	32.7	.4	51.5
.6	14.4	.6	33.3	.6	52.2
.8	15.0	.8	33.9	.8	52.8
(5)	15.7	(11)	34.6	(17)	53.4
.2	16.3	.2	35.2	.2	54.0
.4	17.0	.4	35.8	.4	54.6
.6	17.6	.6	36.9	.6	55.2
.8	18.2	.8	37.0	.8	55.9
(6)	18.8	(12)	37.7	(18)	56.5
.2	19.5	.2	38.3	.2	57 2
.4	20.0	.4	39.0	.4	57.8
.6	20.7	.6	39.6	.6	58.4
.8	21.3	.8	40.2	.8	59.1

Diam.

from one Inch to sixty, and to every $\frac{1}{10}$ of an Inch.

Diam.	*Circumf.*	*Diam.*	*Circumf.*	*Diam.*	*Circumf.*
(19)	59.7	(25)	78.5	(31)	97.4
.2	60.3	.2	79.1	.2	98.0
.4	60.9	.4	79.8	.4	98.6
.6	61.6	.6	80.4	.6	99 2
.8	62.2	.8	81.0	.8	99.9
(20)	62.8	(26)	81 6	(32)	100.5
.2	63.4	.2	82.3	.2	101.1
.4	64.0	.4	82.9	.4	101.8
.6	64.7	.6	83.5	.6	102.4
.8	65.3	.8	84.2	.8	103.0
(21)	65.9	(27)	84.8	(33)	103.6
.2	66.6	.2	85.4	.2	104.3
.4	67.2	.4	86.1	.4	104.9
.6	67 8	.6	86 7	.6	105.5
.8	68.5	.8	87.3	.8	106.2
(22)	69.1	(28)	88.0	(34)	106.8
.2	69 7	.2	88.6	.2	107.4
.4	70.4	.4	89.2	.4	108.0
.6	71.0	.6	89.8	.6	108.7
.8	71.6	.8	90 5	.8	109.3
(23)	72.2	(29)	91.1	(35)	109.9
.2	72.9	.2	91.7	.2	110.6
.4	73.5	.4	92.3	.4	111.2
.6	74.1	.6	93.0	.6	111.8
.8	74.8	.8	96.3	.8	112.4
(24)	75.4	(30)	94.2	(36)	113.1
.2	76.0	.2	94.9	.2	113.7
.4	76.6	.4	95.5	.4	114.3
.6	77.3	6.	96.1	.6	114.9
.8	78.0	8.	96.7	.8	115 6

Diam.

A Table of Circumferences answering to Diameters,

Diam.	*Circumf.*	*Diam.*	*Circumf.*	*Diam.*	*Circumf.*
(37)	116.2	(43)	135.0	(49)	153.9
.2	116.8	.2	135.7	.2	154.5
.4	117.5	.4	136.3	.4	155.2
.6	118.1	.6	136.9	.6	155.8
.8	118.7	.8	137.6	.8	156.4
(38)	119.3	(44)	138.2	(50)	157.0
.2	120.0	.2	138.8	.2	157.6
.4	120.6	.4	139.4	.4	158.3
.6	121.2	.6	140.0	.6	158.9
.8	121.8	.8	140.7	.8	159.5
(39)	122.5	(45)	141.3	(51)	160.1
.2	123.1	.2	141.9	.2	160.8
.4	123.7	.4	142.6	.4	161.4
.6	124.4	.6	143.2	.6	162.0
.8	125.0	.8	143.8	.8	162.6
(40)	125.6	(46)	144.5	(52)	163.3
.2	126.3	.2	145.0	.2	163.9
.4	126.9	.4	145.7	.4	164.6
.6	127.5	.6	146.4	.6	165.2
.8	128.1	.8	147.0	.8	165.8
(41)	128.8	(47)	147.6	(53)	166.4
.2	129.4	.2	148.2	.2	167.1
.4	130.0	.4	148.8	.4	167.8
.6	130.6	.6	149.5	.6	168.3
.8	131.3	.8	150.1	.8	169.0
(42)	131.9	(48)	150.7	(54)	169.6
.2	132.5	.2	151.4	.2	170.2
.4	133.2	.4	152.0	.4	170.8
.6	133.8	.6	152.6	.6	171.5
.8	134.4	.8	153.3	.8	172.1

Diam.

from one Inch to sixty, and to every $\frac{1}{10}$ of an Inch.

Diam.	*Circumf.*	*Diam.*	*Circumf.*	*Diam.*	*Circumf.*
(55)	172.8	(57)	179.0	(59)	185.3
.2	173.4	.2	179.6	.2	185.9
.4	174.0	.4	180.2	.4	186.6
.6	174.6	.6	180.8	.6	187.2
.8	175.2	.8	181.5	.8	187.8
(56)	175.8	(58)	182.1	(60)	188.4
.2	176.4	.2	182.8	.2	189.0
.4	177.1	.4	183.4	.4	189.8
.6	177.8	.6	184.0	.6	190.3
.8	178.4	.8	184.6	.8	191.0

How to turn Barrels into Gallons & *é contra* (Ale-Measure) by the Pen and Slide.)

IN 8 Barrels of Ale, how many Gallons?

As 1 : 32 :: 8 : 256
8

256 Gallons by the Pen.

Now by the Slide.

Set 32 (the Gallons in a Country Ale-barrel) on line B, to Unit on line A, then look for 8 on line A, directly under which on line B, you have 256 (the Gallons required.)

E contra: In 256 Gallons of Ale, how many Barrels?

As 32 : 1 :: 256 : 8
32) 256 (8 Gallons by the Pen.
256

Now by the Sliding Rule.

Set Unit on line B, to 32 on line A, then look for 256 on line A, directly under which on line B, you have 8 (the barrels required.)

A TABLE to convert Barrels into Gallons, and Gallons into Barrels, *Ale Measure*, from one to sixty Barrels.

THE TABLE.

Barrels	*Gallons.*	*Barrels*	*Gallons.*
1	32	31	992
2	64	32	1024
3	96	33	1056
4	128	34	1088
5	160	35	1120
6	192	36	1152
7	224	37	1184
8	256	38	1216
9	288	39	1248
10	320	40	1280
11	352	41	1312
12	384	42	1344
13	416	43	1376
14	446	44	1408
15	480	45	1440
16	512	46	1472
17	544	47	1504
18	576	48	1536
19	608	49	1568
20	640	50	1600
21	672	51	1632
22	704	52	1664
23	736	53	1696
24	768	54	1728
25	800	55	1760
26	832	56	1792
27	864	57	1824
28	896	58	1856
29	928	59	1888
30	960	60	1920

The Explanation or Use of the Table of Squares.

DILIGENTLY obſerve, that the common practice in Gauging of *Ovals*, *viz.* by adding the longer and ſhorter Diameters together, (and taking the half for a mean) is erroneous: For inſtance, ſuppoſe an *Oval*, whoſe longeſt Diameter is 35 inches, and the ſhorteſt 25, theſe added make 60, the half of which is 30, which being taken for a mean Diameter, and ſuppoſing the depth to be 10 inches, in ſuch caſe, under 30, and againſt 10 in the Table of Cylinders, you'll find 32 gallons 5 tenths, which is certainly too much.

But the exact way of gauging an *Oval*, is thus; multiply the Diameters one into the other, then extract the Square-root, and that is the true mean Diameter. But to ſave the trouble of extracting the Square-root to ſuch as can, and to oblige ſuch as cannot, I have here given a Table of Squares, from 1 to 100 Inches, and to every two tenths of an Inch, which will very much facilitate the work.

For *Example*; I'll ſuppoſe the above *Oval*, whoſe longeſt Diameter is 35 Inches, and ſhorteſt 25, which multiplied one into the other, produce 875, which number you are to look for in this Table of Squares; but as it is not to be found there, you muſt now, (and ſo in all ſuch caſes) take the neareſt number to it, which is 876, againſt which in the ſaid Table, you have 29.6 for the Root or Diameter, which Diameter you are to look for in the Table of Cylinders, in which Table, againſt 10 the Depth, you have 31 gallons and 6 tenths, which is the exact content; though leſs than what was given by the vulgar way, by 1 gallon (1 tenth excepted:) juſt ſo, according to the largeneſs of the veſſel, and difference of Diameters, will the errors in all ſuch operations be more or leſs.

A TABLE OF SQUARES, BY J. B.

(1)	1.00	(8)	64 00	(15)	225.00	(22)	484.00
.2	1.44	.2	67.24	.2	231.04	.2	492 84
.4	1.96	.4	70.56	.4	237.16	.4	501.76
.6	2.56	.6	73.96	.6	243.36	.6	510.76
.8	3.24	.8	77.44	.8	249.64	.8	519.84
(2)	4.00	(9)	81.00	(16)	256.00	(23)	529.00
.2	4.84	.2	84.64	.2	262.44	.2	538.24
.4	5.76	.4	88.36	.4	268.96	.4	547.56
.6	6.76	.6	92.16	.6	275.56	.6	556.96
.8	7.84	.8	96.04	.8	282.24	.8	566.44
(3)	9.00	(10)	100.00	(17)	289.00	(24)	576.00
.2	10.24	.2	104.04	.2	295 84	.2	585.64
.4	11.56	.4	108.16	.4	302.76	.4	595.36
.6	12.96	.6	112.36	.6	309.76	.6	605.16
.8	14.44	.8	116.64	.8	316.84	.8	615.04
(4)	16.00	(11)	121.00	(18)	324.00	(25)	625.00
.2	17.64	.2	125.44	.2	331.24	.2	635.04
.4	19.36	.4	129.96	.4	338.56	.4	645 16
.6	21.16	.6	134.56	.6	345.96	.6	655.36
.8	23.04	.8	139.24	.8	353.44	.8	665.64
(5)	25.00	(12)	144.00	(19)	361.00	(26)	676 00
.2	27.04	.2	148 84	.2	368 64	.2	686.44
.4	29.16	.4	153.76	.4	376 36	.4	696 96
.6	31.36	.6	158.76	.6	384.16	.6	707.56
.8	33.64	.8	163.84	.8	392 04	.8	718.24
(6)	36 00	(13)	169.00	(20)	400.00	(27)	729.00
.2	38.44	.2	174.24	.2	408.04	.2	739.84
.4	40.96	.4	179.56	.4	416.16	.4	750.76
.6	43.56	.6	184.69	.6	424.36	.6	761.76
.8	46.24	.8	190.44	.8	432.64	.8	772.84
(7)	49.00	(14)	196.00	(21)	441.00	(28)	784.00
.2	51.84	.2	201.64	.2	449 44	.2	795.24
.4	54.76	.4	207.36	.4	457.96	.4	806.56
.6	57.76	.6	213 16	.6	466.56	.6	817.96
.8	60.84	.8	219.04	.8	475.24	.8	829.44

A TABLE OF SQUARES, BY J. B.

(29)	841.00	(36)	1296.00	(43)	1849.00	(50)	2500.00
.2	852 64	.2	1310.44	.2	1866.24	.2	2520 04
.4	864.36	.4	1324.96	.4	1883.56	.4	2540.16
.6	876.16	.6	1339.56	.6	1900.96	.6	2560.86
.8	888.04	.8	1354.24	.8	1918.44	.8	2580.64
(30)	900.00	(37)	1369.00	(44)	1936.00	(51)	2601.00
.2	912.04	.2	1383.84	.2	1953.64	.2	2621.44
.4	924.16	.4	1398.76	.4	1971.36	.4	2641.96
.6	936.36	.6	1413.76	.6	1989.16	.6	2662.56
.8	948.04	.8	1428.84	.8	2007.04	.8	2683.24
(31)	961.00	(38)	1444.00	(45)	2025.00	(52)	2704.00
.2	973.44	.2	1459.24	.2	2043.04	.2	2724.84
.4	985.96	.4	1474.56	.4	2061.16	.4	2745.76
.6	998 56	.6	1489.96	.6	2079.36	.6	2766.76
.8	1011.24	.8	1505 44	.8	2097.64	.8	2787.84
(32)	1024 00	(39)	1521.00	(46)	2116 00	(53)	2809.00
.2	1036.84	.2	1536.64	.2	2134.44	.2	2830.24
.4	1049.76	.4	1552.36	.4	2152.96	.4	2851.56
.6	1062.76	.6	1568.16	.6	2171.56	.6	2872.96
.8	1075 84	.8	1584.04	.8	2190.24	.8	2894.44
(33)	1089.00	(40)	1600.00	(47)	2209.00	(54)	2916.00
.2	1102.24	.2	1616 04	.2	2227.84	.2	2937.64
.4	1115.56	.4	1632.16	.4	2246.76	.4	2959.36
.6	1128.96	.6	1648.36	.6	2265.76	.6	2981.16
.8	1142.44	.8	1664.64	.8	2284.84	.8	3003.04
(34)	1156.00	(41)	1681.00	(48)	2304.00	(55)	3025.00
.2	1169.64	.2	1697.44	.2	2323.24	.2	3047.04
.4	1183.36	.4	1713.96	.4	2342.56	.4	3069.16
.6	1197.16	.6	1730.56	.6	2361.96	.6	3091.36
.8	1211.04	.8	1747.24	.8	2381.44	.8	3113.64
(35)	1225.00	(42)	1764.00	(49)	2401.00	(56)	3136.00
.2	1239.04	.2	1780.84	.2	2420.64	.2	3158.44
.4	1253.16	.4	1797.76	.4	2440.36	.4	3180.96
.6	1267.36	.6	1814.76	.6	2460.16	.6	3203 56
.8	1281.64	.8	1831.84	.8	2480.04	.8	3226.24

A TABLE OF SQUARES, BY J. B.

(57)	3249 00	(64)	4096.00	(71)	5041.02	(78)	6084.00
.2	3271 84	.2	4121.64	.2	5069 44	.2	6115.24
.4	3294.76	.4	4147.36	.4	5097.96	.4	6146.56
.6	3317.76	.6	4173.16	.6	5126 56	.6	6177.96
.8	3340.84	.8	4199.04	.8	5155.24	.8	6209.44
(58)	3364.00	(65)	4225.00	(72)	5184.00	(79)	6241.00
.2	3387.24	.2	4251 04	.2	5212.84	.2	6272.64
.4	3410.56	.4	4277.16	.4	5241.76	.4	6304.36
.6	3433.96	.6	4303 36	.6	5270.76	.6	6336.16
.8	3457.44	.8	4329.64	.8	5299.84	.8	6368.04
(59)	3481.00	(66)	4356.00	(73)	5329.00	(80)	6400.00
.2	3504.60	.2	4382.44	.2	5358.24	.2	6432.04
.4	3528.36	.4	4408.96	.4	5387.56	.4	6464.16
.6	3552.16	.6	4435.56	.6	5416.96	.6	6496.36
.8	3576.04	.8	4462.24	.8	5446.44	.8	6528.64
(60)	3600.00	(67)	4489.00	(74)	5476.00	(81)	6561.00
.2	3624.04	.2	4515.84	.2	5505.64	.2	6593.44
.4	3648.16	.4	4542.76	.4	5535.36	.4	6625.96
.6	3672.36	.6	4569.76	.6	5565.16	.6	6658.56
.8	3696.64	.8	4596.84	.8	5595.04	.8	6691.24
(61)	3721.00	(68)	4624.00	(75)	5625.00	(82)	6724.00
.2	3745.44	.2	4651.24	.2	5655.04	.2	6756.84
.4	3769.96	.4	4678.56	.4	5685.16	.4	6789.76
.6	3794.56	.6	4705.96	.6	5715.36	.6	6822.76
.8	3819.24	.8	4733.44	.8	5745.64	.8	6855.84
(62)	3844.00	(69)	4761.00	(76)	5776.00	(83)	6889.00
.2	3868.84	.2	4788.64	.2	5806.44	.2	6922.24
.4	3893.76	.4	4816.36	.4	5836 96	.4	6955.56
.6	3918.76	.6	4844.16	.6	5867.56	.6	6988.96
.8	3943.84	.8	4872.04	.8	5898.24	.8	7022.44
(63)	3969.00	(70)	4900.00	(77)	5929.00	(84)	7056.00
.2	3994.24	.2	4928.04	.2	5959.84	.2	7089.64
.4	4019.56	.4	4956.16	.4	5990.76	.4	7123.36
.6	4044.96	.6	4984.36	.6	6021.76	.6	7157.16
.8	4070.44	.8	5012.64	.8	6052.84	.8	7191.04

A TABLE OF SQUARES, BY J. B.

(85)	7225.00	(89)	7921.00	(93)	8649.00	(97)	9409.00
.2	7259.04	.2	7956.64	.2	8686.24	.2	9447.84
.4	7293.16	.4	7992.36	.4	8723.56	.4	9486.76
.6	7327.36	.6	8028.16	.6	8760.96	.6	9525.76
.8	7361.64	.8	8064.04	.8	8798.44	.8	9564.84
(86)	7396.00	(90)	8100.00	(94)	8836.00	(98)	9604.00
.2	7430.44	.2	8136.04	.2	8873.64	.2	9643.24
.4	7464.96	.4	8172.16	.4	8911.36	.4	9682.56
.6	7499.56	.6	8208.36	.6	8949.16	.6	9721.96
.8	7534.24	.8	8244.64	.8	8987.04	.8	9761.44
(87)	7569.00	(91)	8281.00	(95)	9025.00	(99)	9801.00
.2	7603.84	.2	8317.44	.2	9063.04	.2	9840.64
.4	7638.76	.4	8353.96	.4	9101.16	.4	9880.36
.6	7673.76	.6	8390.56	.6	9139.36	.6	9920.16
.8	7708.84	.8	8427.24	.8	9177.64	.8	9960.04
(88)	7744.00	(92)	8464.00	(96)	9216.00	(100)	10000.00
.2	7779.24	.2	8500.84	.2	9254.44		
.4	7814.56	.4	8537.76	.4	9292.96		
.6	7849.96	.6	8574.76	.6	9331.56		
.8	7885.44	.8	8611.84	.8	9370.24		

Gauging and Meaſuring by the Pen and Sliding Rule.

Queſtion 1ſt.

THERE is a Well, whoſe Diameter is 608 Inches, and the depth 300, I demand how many Barrels Ale meaſure will this Well contain?

I divide 608 by 10, which is done by always changing the laſt figure into a Decimal which will be 60.8, which find in the Table of Cylinders, multiply by 10, the $\frac{1}{10}$ for 300, then multiply by 100, the ſquare of 10, which divided by 32 gives the content.

Queſtion 2d.

How to find an Addend upon the Sliding Rule.

Set Unit on line B, to the Altitude on line A, and under the difference of Diameters on line A, you have the Addend upon line B.

Queſtion 3d.

Having found the Addend, how to find the Diameter by the Slide.

Set the Addend on line B, to Unit on line A, then find on ſaid line A, half the Altitude, under which on line B, you have a number, which added to the bottom Diameter, will make a mean Diameter.

Queſtion 4th.

Having found the Addend and Mean, how to find the Area by the Slide.

Set Unit on line C, to the Gauge-point on line D, then look for the Diameter on line D, under which you have the Area on line C.

Note, When the Area of a Maſh Keeve is required, you muſt work by the Gauge-point for Maſhes.

Having the Areas and wet Inch, how to find the content by the Pen and Slide.

First by the Pen. Note, Where your wet does exceed 10 Inches, you muſt multiply your firſt Area by 10, or which is the ſame (remove your point one figure towards the right hand) then multiply your 2d Area by the remainder of your wet, and thoſe two Products added, give the content in Gallons.

Now by the Slide. Set the wet on line B, to Unit or 1 on line A, then look for the Area on line A, directly under which on line B, you have the number of Gallons, [illegible] your firſt Area and wet; then proceed to your 2d operation.

Obſerve (where your wet Inch) does exceed ten,
You muſt operate twice by Slide and Pen.

Queſtion 5th.

What is the Intereſt of 250*l.* ſterling in one Year at 6*l.* per cent. by the Slide.

The Proportion is thus.

As 100 Pound principal, is to 6*l.* its Intereſt in one Year,
So is any other Sum, to its proportional Intereſt.

Set 100 in the middle upon line A, to 6 (the Intereſt thereof) upon line B, then againſt any other ſum upon line A, you have the Intereſt upon line B: thus, the Rule being fixed as here directed, againſt 250 Pound upon line A, you have 15 upon line B; which is the Intereſt of 250 Pound in one Year. (And without moving the Rule) I likewiſe find that if the Principal

Pound.	*Pound Interest.*
1000	60
850	51
600	36
360	21.6
50	3

Be ... Intereſt.

Queſtion 6th.

How to find an Addend by the Pen.

You muſt ſubtract the leſſer Diameter from the greater, (and that difference divided by the Altitude) quotes the Addend.

Queſtion 7th.

Having found the Addend, how to find a number by the Pen, (which number added to the leſſer Diameter,) will make a mean Diameter.

The method is, multiply half the wet Inch by the whole Addend, (or which will be the ſame) multiply half the Addend by the whole wet Inch, and the Product either way, added to the leſſer Diameter, makes a mean Diameter.

Five Men, C, D, E, F, and G, make a Bank of 360 Pound, with which they trade, and gain 40 Pound, what part of this gain muſt each Man receive to balance his Money put in?

The Proportion is.

As the whole Stock is to the whole gain,
So is each Man's particular Stock, to his particular gain.

Therefore,

Therefore,

Set 360 the whole Stock upon A, to 40 the whole gain upon B, then againſt each Man's Stock upon A, you have his gain upon line B: thus againſt 108 upon A, you have 12 upon B. ſo C, who put in 108 Pound, ſhall have 12 Pound of the gain; and ſo of the reſt. By which it appears that this Queſtion (which by the Pen in Fellowſhip, would require five operations) is reſolved by the Slide at one.

C	108	12
D	81	9
E	63	7
F	72	8
G	36	4
	360	40

As I began this treatiſe with the deſcription of a Circle, I think it proper to give you the proportions of a Circle, according to *Forster*, *Moreland*, *Taylor*, *Everard*, &c.

You have already ſeen, that if the Diameter of a Circle be 1, the Circumference will be 3.141592, and the Area .785398; the Squre Root of .785398 is .886221, and this is the ſide of a ſquare which is equal to the Area of a Circle whoſe Diameter is 1; and the Square Root of .5, *viz.* .707106, is the ſide of the greateſt ſquare that can be inſcribed in a Circle whoſe Diameter is 1; ſo that if the Diameter of a Circle be 1,

The	Circumference	is	3.141592
	Square Equal		.886221
	Square inſcribed		.707106
	Area		.785398

Note further, That if the Circumference of a Circle be 1,

The	Diameter	will be	.318310
	Square Equal		.282092
	Square inſcribed		.225079
	Area		.079577

If the Area of a Circle be 1,

The	Diameter	is	1.128378
	Circumference		3.54491

If the Circumference of a Circle be 4,

The	Diameter	is	1.27342
	Area		

If the Diameter of a Circle be 4,

The	Circumference	is	12.56636
	Area		

In all theſe caſes the Area is ſquare Inches, the other terms being lines, do refer to Lineal Inches: theſe things premiſed, I ſhall here add ſome uſeful Queſtions, which may be reſolved either by the Pen arithmetically, or by the Slide inſtrumentally.

Gauging or Measuring.

1ſt, The Diameter of a Circle given, to find the Circumference.

As 1, is to 3.141592, or as .31831 is to 1:
So is the Diameter to the Circumference.

2d, The Circumference given to find the Diameter.

As 1, is to .31831, or as 3.141592 is to 1:
So is the Circumference to the Diameter.

3d, The Diameter of a Circle given, to find the Area.

As 1, is to .78539, or as 1.27324 is to 1:
So is the ſquare of the Diameter to the Area required.

4th, The Area of a Circle given to find the Diameter.

As 1, is to 1.27324, or, as .78539 is to 1:
So is the Area, to the ſquare of the Diameter ſought.

5th, The Circumference of a Circle given, to find the Area.

As 1, is to .079578, or, as 12.56636 is to 1:
So is the ſquare of the Circumference to Area ſought.

6th, The Area of a Circle given to find the Circumference.

As 1, is to 12.56636, or, as .079578 is to 1:
So is the Area, to the ſquare of the Circumference, whoſe Square Root is the Circumference required.

Measuring.

The Circumference and Length of any round Tree being given (in foot meaſure) to find the content.

Rule.

(The Circumference of that Circle whoſe Area is 1, is 3.544)

Therefore,

As 3.544 upon line D, is to the length upon line C,
So is the Circumference upon D, to the content upon C.

Example.

Example.

Suppoſe the length of a Tree be 20 Feet, and the Circumference 4 Feet, what is the content?

Set 3.544 upon D, to 20 (the length) upon C, then againſt 4 the Circumference upon D, you have 25.46 upon C, that is, 25 Feet and almoſt an half; and ſo much is the content.

The length and ſide of any piece of ſquare Timber being given in foot meaſure, to find the content.

The proportion is,

As 1 upon D, is to the length upon C,
So is the ſide upon D, to the content upon C.

Example.

There is a piece of Timber exactly ſquare, each ſide at either end being 1.5 Feet, and the length 20 Feet, how many ſolid Feet does this piece contain?

Set 1 upon D, to 20 upon C, and againſt 1.5 upon D, is 45 upon C, which is the content ſought.

The ſide of any ſquare ſolid being given in Inches, and the length in Feet, to find the content in Feet.

The proportion in the laſt Problem will hold here, if inſtead of 1, you make uſe of 12 for the firſt term.

Example.

Let the ſide be 18 Inches, and the length 20 Feet, what is the content in Feet? *Anſwer*, 45. For,

As 12 upon D, is to 20 the length upon C,
So is 18 the ſide upon D, to 45 the content upon C.

To meaſure Brick Work.

Brick work is commonly meaſured by the Rod Square, which is 16.5 Feet in length, and as much in breadth, and conſequently each ſquare Rod doth contain 272.25 ſquare Feet, for 16.5 multiplied by 16.5, is 272.25.

Note alſo, All Brick Work muſt be reduced to the ſtandard meaſure of one Brick and half thick.

The Rule.

Multiply the height by the length, and divide the Product by 272.25, the Quotient will be the true content, if the Wall be juſt 1½ Brick thick: or, having the length and height in Feet, you may find the content readier by the Slide, by this proportion.

As

As 272.25 upon B, to the height upon A,
So is the length upon B, to a fourth number upon A; which is the true content, if the Wall be 1½ Brick thick.

Example.

There is a Wall 16 Feet high, and 97 feet long; how many ſquare Rods doth this Wall contain at 1½ Brick thick? *Anſwer*, 5 Rods and ſeven tenth parts: For,

As 272.25 upon B, is to 16 the height upon A,
So is 97 the length upon B, to 5.7 upon A.

Now that (in all caſes) you may find the content at one operation; I ſhall here lay down certain fixed numbers for any thickneſs which you can probably meet.

Viz.			
	1	Bricks Thick	408.37
	1½		272.25
	2		204.19
	2½		163.35
	3		136.12
	3½		116.68

By theſe Numbers the content of any Wall at any thickneſs here mentioned may be found, either by the Pen or Slide; and the proportion is,

As the Number proper to the thickneſs, is to the height,
So is the length to the content.

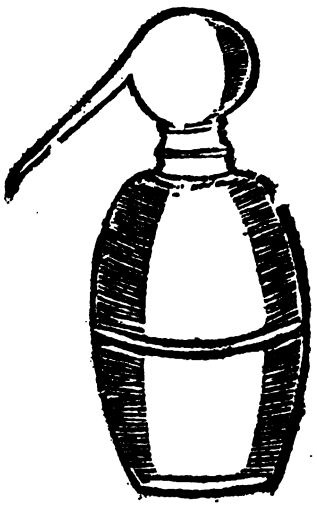
The

The form of a common Still, with the different methods of Gauging it.

Optio ſit tua.

FIRST divide the Circumference into four equal parts, both at the top and bottom, which may be marked, 1ſt, with Chalk; after which draw perpendicular lines from the top to the bottom, which is commonly called quartering the Still: then take a rule and ſet it ſtanding up by the quarter lines, and make a mark with chalk on the line at every Inch exactly; then take the Diameter at every Inch, &c. Or if the Diameter be taken at (every four Inches) it will anſwer near enough in practice.

The form of a common Still.



Or thus: take the Diameter near the top, a ſecond at the middle, and the third near the bottom of the Still; theſe three added together, the third part of the *tot*, makes a mean; and then: as the Gauge point, is to the depth, ſo is the mean Diameter, to the content.

By the Pen, ſquare the mean Diameter, and work as in caſe of a Cylinder; but as the Diameter cannot conveniently be taken by our common inſtruments, I would take the Circumference,

cumferenee (as above directed) and theſe three added, the third part ſerves for a mean Circumference. Then ſay, if 22 gives 7, what will the Circumference give? The Quotient is your mean Diameter, &c.

Note, That as it has been found by frequent practice, that the above directions do not come up to the wiſhed for exactneſs, I would recommend the following mechanical method, *viz.* Let our Still be filled to the neck, and thence drawn off into ſome regular veſſel, and there Gauged.

EXPLANATION

Explanation of the Stock Book for common Brewers in the Cities of Dublin and Cork, with some general directions.

ON December 27th morning 6 on the right hand page the Brewer is at work, and the condition of the houſe is thus C: L. T. S. which ſignifies Copper, Liquor, Tap, Spending, at the ſame time take an exact account of all depending Gauges, if any.

On the left hand page the ſame 27th December E: 5: the other officer of the diviſion hath a Gauge of the firſt worts hot, entering the groſs dips of the Coolers on the margin, againſt No. 2 & 3, and in the next column, under the title depth, he inſerts the nett dips agreeable to the levels given to him by his Surveyor, in the next two ſmall columns are the quality and condition marked thus X: h: *viz.* ſtrong hot, in the laſt column the gauge is caſt up, and after totaling you muſt deduct a tenth part for waſte, which is done by removing the ſaid total one figure from the left hand, and ſubtracting the one Sum from the other, the remainder is the Nett Gallons as in the ſpecimen.

At the ſame time ſtocking the Store houſe, and taking a particular account of the depending Guiles, Tunnages and old Ale, at the ſame time he ſhews the condition of the houſe, *viz.* hath a Gauge of the goods and C vj R: *viz.* ſmall Beer raw, in the Copper, the ſame officer returns at E: 7: and hath a ſecond Gauge of the ſtrong warm, and a hot Gauge of the ſmall in Cooler No: 1, with the perſon's name who declares the length; from both he muſt deduct a tenth part for waſte, as above. In like manner next day the morning officer hath an entire Gauge of the whole Brewing, and in the afternoon the evening officer hath it in the Tun, and ſo on alternately till Tunnage every time you viſit the houſe, ſhewing the true ſtate thereof.

You are to give immediately notice to your Surveyor, in writing, when any Brewer erects, ſets up, alters or enlarges any Tun, Back, Cooler or Copper, or of his making uſe of any Store-houſe, Cellar or place for laying any Beer, Ale or Worts; alſo when you ſhall diſcover, by the diſparity of Gauges or otherwiſe, that any Cooler has been altered or put out of level.

When any Tunnages come in charge, you are, then, to take an entire ſtock of all Beer or Ale in the Brewer's cuſtody, ſhewing at each time you make a viſit, the condition or ſtate of the houſe, according to the directions in the firſt Article of the Officers who ſurvey Foot Walks.—And you are in your morning viſits, if poſſible, to take the Gauge entire in the Coolers of all ſuch Worts as were brewed of the evening before.

William Hayes December 27th.

30. Goods 2500.

	B		x	v
30th.	54	Tunn'd	2160.	984

Hours.	No.	Depth.	Q.	C.	Content
E. 5.	C.	VI R.			
					922. 0
4. 9.	2	4. 5.	x	h	115. 2
4. 4.	3	3. 9.	x	h	1175. 0
					352. 5
					2564. 7
					256. 4
Ep. 7.	C.	S——			2308. 3
4. 7.	2		x	w	
4. 3.	3		x	w	1067. 9
4. 2.	1	5. 5.	VI	h	106. 7
L. D. *p.*	*Ja.*	*Jones.*			1174. 6
					117. 4
					1057. 2
28th E. 4.	C.	S——			
Tun.	2	50. 0.	x	wt.	2270. 9
Area.	4	03. 2.	x	wt.	12. 8
					2283. 7
29th. E. 6.	C	S——			
Tun.	2	20. 5	x	dry	2270. 9
		50. 3	x	wt.	25. 6
Drainings	in				2296. 5

x	VI
Charge 2355.	1068.

William Hayes December 27th.

Goods.

	B		x	v
30th.	54	Tunn'd	2160.	984

Hours.	No.	Depth.	Q.	C.	Content
M. 6.	C.	L. T. S.	—		
28th. M. 5	C.	S——			
					922. 2
4. 5.	2	4 1.	x	c	23. 1
4. 1.	3	3. 6	x	c	1175. 0
					235. 0
					2355. 0
3. 7.	1	5. 0.	VI	c	1067. 9
29th. M. 6	C.	S——			
Tun	0	20 4	x	dry	2270. 9
		50. 4	x	wt	30. 3
21. 0	—	10.0	x	wt	15. 9
					3317. 1
30th. M. 7	C.	L. L. G.	—	tu'd	54 Bs. x.

William Hayes Stock.										Do. continued.							
Month and Day.	Hour.	New-Ale / Old-Ale.		New Small.	Old Small.	New Beer.	Old Beer.	Barrels returned		Hogsheads return'd. / Pipes returned.			Gallons X *per* Tunnage.	Gallons VI *per* Tunnage.		Gallons Beer X *per* Tunnage.	
Hours.	No	Depth		Q.	C.	Content				Hours.		No.	Depth.	Q.	C.	Content	
Dec. 27. E	5	—	40	—	12	—	57	1		4	2						
28. E.	4	—	31	—	6	—	54	18		4	2						
29. E.	6	—	21	24													
30. E.	4	54	8	—	10	—	52	14		4	2	{	2160	984			
31. E.	6	—	58														
Jan. 1. E.	5	—	42														
Charge										Charge							

Mr. THOMAS WALLIS's

Third Table of Segments, Bung 100, Middle 96:9, Head 87:0.

V:S	*Segment.*	V:S	*Segment.*	V:S	*Segment.*	V:S	*Segment.*
1	.000438	99	.99562	26	.195402	74	.804598
2	.001742	98	.998258	27	.206962	73	.793038
3	.003893	97	.996107	28	.218674	72	.781326
4	.006874	96	.993126	29	.230529	71	.769471
5	.010667	95	.989333	30	.24252	70	.75748
6	.015255	94	.984745	31	.254639	69	.745361
7	.020564	93	.979436	32	.266877	68	.733123
8	.026603	92	.973397	33	.279229	67	.720776
9	.033156	91	.966844	34	.291686	66	.708314
10	.040180	90	.95982	35	.304241	65	.695759
11	.047637	89	.952363	36	.316888	64	.683112
12	.055493	88	.944507	37	.32962	63	.67038
13	.063718	87	.936282	38	.34243	62	.65747
14	.072285	86	.927715	39	.355312	61	.644688
15	.081171	85	.918829	40	.36826	60	.63174
16	.090357	84	.909643	41	.381267	59	.618733
17	.099826	83	.900174	42	.394397	58	.605673
18	.109560	82	.89044	43	.407434	57	.592566
19	.119545	81	.880455	44	.420582	56	.579418
20	.129766	80	.870234	45	.433765	55	.566235
21	.140212	79	.859788	46	.446977	54	.553023
22	.150869	78	.849131	47	.460212	53	.539788
23	.161728	77	.838272	48	.473465	52	.526535
24	.172776	76	.827224	49	.48673	51	.51327
25	.184004	75	.815996	50	.500000	50	.500000

Compared by John Morris, Examiner.

The Explanation of the Country Gaugers Stock Book.

YOU have an example of a ſtock ſet you after the uſual manner: wherein you muſt obſerve if any caſk is gone from the houſe, you are to enter this character ⊙; and likewiſe if any caſk be broken or ſent abroad not to return again, and the Content left out, you muſt uſe the ſame; and if a new caſk comes in, you are to enter it in ſuch vacant place, not entering the Content amongſt the others, but juſt over it as in by-caſk Content 6 gallons after No. 8, that is ſtocked the 14th E. 5. continuing all caſks in ſuch manner, till next tranſcription, then entering them amongſt the other Contents, always having this regard not to extend your ſtock further than neceſſity obliges you.

On the next page to the right hand you have the firſt two columns from the margin entitled M. K. Cop^{r}. which ſignifies Maſh, Keeve and Copper, under which you are always to enter their condition, when at work, with the day and hour as 8th. M. 11. &c. ſave when you ſtock at the ſame time: in which caſe you may do it all along from your ſtock, which denotes the time of your remark on thoſe utenſils, as the 4th. M. 7. In taking your Gauges you are to enter the Areas of all utenſils as in page 3d. (from your ſtock incluſive) and under them your dips with the quality and condition if hot or warm with W only, and in the two laſt columns, towards the right hand of ſaid page, you are to place the amount of your Gauge and ſo on till tunned; after the ſame manner, on a direct line, and if you happen to have more Gauges of a Brewing than you have ſo laid out your book for, you may repeat them under your ſecond, third or fourth Gauges, but never under your firſt Gauge, as in the ſpecimen 8^{bre}. 8th. M. 11. the beſt of which Gauges you are to place on the 2d page under the title X VI in the two laſt columns ſave one, where you are to place the amount of Malt in gallons, and ſuch beſt Gauge or Tunnage, whichſoever produces moſt, you are to enter under the title charge and at the end of the month make one total of the whole as you ſee in the Scheme.

With very little variation, you may keep ſtock on, and gauge common Brewers in the country, in the ſame book.

Dalgeny

Dalgeny

Nathaniel Gulliver

		1	3	5	7						
		43	42	12	23						
		41	44	21	10						
Oct.	1 E 7	¾ d 1	1	o o	o o	o	=				
	3 M 9	¾	1	o o	o o	o	=				
	4 M 7	¼ ¼ d	1	o o	o o	o	=				
	6 M 9	⅛ ¼	¾	o o	o o	o	=				
	7 E 4	o ⅛	½	o o	vj o	o	=				
4	9 M 8	o ≈	⅛	o o	¾ o	o	=				
	11 M 7	1/10 1 d	o	o o	¼ o	o	=	x 20.9			
9	12 M 9	o 1	≈ o	o o	o vj	= 06		04.4			
	14 E 5	o ¾	1	o o	o o	¾	1 :=	Ct. 6	*from*	*plus*	
	16 E 3	o ½	1 d	o o	o o	½	1 :=				
17	18 M 9	o ¼	1	o o	≈ o		1 := d		—	x	—
	20 M 7	¾ ⅛ ¾		o o	1 o	o	1 :=	No. 1	—	22	wt. 15
	21 E 4	½ o	½	o o	1 d o	⊙	⊙				
	24 E 1	¼ o	¼	o o	1	⊙	=				

M. K. Copr.				Charge		Tunnage		
	38			X	VI	X	VI	goods
	14	L.						
8 M. 11	16	L.						
9.				44	21	41	21	49
12.				50	11	49	10	56
20.				53		52		
		8br.	Ch[rd]	147	32			

1st. GAUGE.

21.0 20.4 20.2 21.9 16.0

M.K.Copr. 1 2 3 4

	38	5.22 4.36	3.60 2.80	3.14 2.50	3.80 2.97	2.00 1.75		X	VI	
Oa. 4 E 7.	—	VI W 05 C	X W 08.7	X W 09.0	—	—	—	42	20	
9 M 8	—	—	X 05.0	X 10.0	—	X 06.1	VI 20.9 07.0	50	11	
17 M 9	—	—	X 14.1	No.	VI	—	X 23.9 05.0	53	—	

2d GAUGE.

20.4 20.2 21.0 16.0

	1	2	3	4				X	VI
	3.60 2.80	3.14 2.50	3.80 2.17	2.00 1.75					
Oct. 3 M 9	—	x 07.0	x 09.0	VI 11.5	—	—	—	44	21
10 E 3	—	—	x 07.0	VI 06.0	x 20.9 05.0	x 20.9 13.5	—	50	11
18 M 9	—	x 12.0	part	Tunn'd	—	—	Tu'd	21 31	—

3rd GAUGE.

	1	2	3	4				
	3.60 2.80	3.14 2.50	3.80 2 97	2.00 1.75			X	VI
Oct. 6 M 9	—	x 15.5	—	vi 11.0	—	—	42	20 /
11 M 7	—	—	x 15.0	vi 0.60	—	—	49	11
20th	Tunn'd							

4th GAUGE.

	1	2	3	4						
	3.60 2.80	3.14 2.50	3.80 2 97	2.00 1.75					X	VI
Oct. 7 E 4	—	x 15.0	—	VI	Tunn'd		—	—	41	—
8 M 11	—	x 15.0	—	5th	Gauge		—	—	41	—
12.	—	Tunn'd								

The explanation of the Distillery.

IN the firſt column, you have the Month, Day, and Hour when ſurveyed; in the ſecond are the numbers of Waſh backs or veſſels made uſe for Gauge and Stock of Pot Ale or Waſh; and under theſe numbers are the Areas of each veſſel at every ten Inches upwards: viz. at 5, 15, and 25, under No. 1 and 2; but when the veſſel is of an equal wideneſs from the top to the bottom, then one Area will ſerve, as under No. 3. and when there are any veſſels for working, which are not in the dimenſion book; in ſuch caſes, the mean Diameter of ſuch veſſels muſt be taken, as you ſee under No. 4, 5, and 6. Next you have the numbers and contents of your Stills, and the numbers, Bungs and contents of Caſks for Singlings or low Wines to No. 4, and from No. 5 forward; the like for ſtrong Waters and Spirits.—December the 1ſt. M. 7 you have the whole ſtock of Pot Ale, which when caſt up is found to be 209 Gallons, and placed in the column for Pot Ale, the Stills ſilent and the Singling Caſks all empty: but in the ſtrong Water Caſks No. 6 is, 10, and No. 7. —9 .1 Inches wet.—At E 6 the Houſe is found as in the M. except the decreaſe of Spirits, which appears per Stock. On the 2d M 8 there is a decreaſe of Pot Ale out of No. 1, 2 and 3 of 81 Gallons, which is ſhewn in the proper column, and which when reduced to ſtrong Waters, produces 9 Gallons; the firſt Still remarked thus P✓ denoting by that character, the Still new come down; otherwiſe (with an M if charged with Moloſſes) at the ſame time there appears an increaſe of Singlings, viz. 2. 5 wet in No. 2, and a decreaſe of ſtrong Waters.——The ſame day M 12 you have the Pot Ale or Waſh in the ſame condition, as in the M Survey, with the Still remarked thus —— denoting the Still half off, at the ſame time an increaſe of Singlings in No. 2, and the Spirits the ſame as in the ſurvey before. At E the ſtock of Pot Ale is as in the M, and Still off; and in the Singling Caſk, No. 2, you have 15 Inches wet, which produces 21 Gallons, and that reduced gives 7 Gallons of ſtrong Waters; the ſtock of ſtrong Waters the ſame as in the two former ſurveys. December the 3d M 6 there is a decreaſe of 64 Gallons of Pot Ale, and both Stills at work, viz. No. 1 upon Pot Ale, and No. 2 remarked thus, S✓ denoting Singlings new down; at the ſame time you have an increaſe of new ſtrong Waters in No. 5. At E 7 the Pot Ale is as in the M, the Stills off, and an increaſe of Singlings 10 .5 wet in No. 1, which produces

19 .4

19 .4 and that reduced gives 6 .3 of ſtrong Waters and in No. 5, you have 10 wet, which gives 8 .9 Gallons of new ſtrong Waters. On the 4th M 8 the firſt Still is charged with the remainder of Pot Ale, viz. 64 Gallons, which reduced makes 7 .1 of ſtrong Waters; the ſecond Still being charged with Singlings from No. 1, and an increaſe in No. 2, with a ſmall decreaſe of ſtrong Waters: at the ſame time you find them brewing. At M 12 the firſt Still is remarked half off thus —— and the ſecond Still near off diſtinguiſhed thus /^ with a further increaſe of Singlings and ſtrong Waters. At E 8 No. 1, 2 and 3 have a freſh charge of Pot Ale, which gives 81 Gallons, the Stills off, and an increaſe of Singling in No. 2, which gives 19 .0, and that reduced to ſtrong Waters gives 6 .3. Alſo a further increaſe of ſtrong Waters in No. 8, making 8 .5. The 5th M 7. the Waſh backs continue as they were, and the ſecond Still charged with the remainder of the Singlings, and a further increaſe of ſtrong Waters in No. 8. At E. 6 the backs remain the ſame as in the M, and the ſecond Still off, with an increaſe in No. 8, which gives 7 .1.

N.B. By an Act made in the 4th of Geo I. upon any decreaſe of Waſh from Corn malted or unmalted, or any other Grain; yon are to charge the Diſtiller with a ninth part reduced into ſtrong Waters, and a third part of the low Wines, or firſt extraction of ſuch Waſh. But from a decreaſe of Waſh made from Sugar Moloſſes, or any decayed Wines, with a ſixth part; and one half from low Wines made from ſuch Waſh.

And obſerve, that you are to make your charge from the beſt amount, either in Waſh or Pot Ale, Low Wines or Singlings, or produce of Spirits or ſtrong Waters.

When a Still is freſh charged with Pot Ale, character it thus .. .. P
If with Moloſſes .. .. M
When charged with Singlings .. .. .. S
And when with Low Wines made from Moloſſes, &c. L W

And to ſhew the condition of the Still upon your Survey, you muſt remark thus, (both in your Check Book, and Minute Paper:)

√
P Denotes newly come down.
——— Denotes half off.
/^ Near off.
Off denotes it quite off.

Atherdee

Atherdee
John George

Gauge and Stock of Pot-Ale.

Month, Day, and Hour.	1	2		4	5	6			1	2	Gallons of Pot-ale.	Decreafe of Pot-ale.	Reduced to X Waters.
	2.5	2.4		Diar	Diar	Diar			Still.	Still.			
	2.1	.0	3.5	27.8	27.5	30.5			84	21			
	1.7	1.5											
Dec. 1 M 7	16.0	2 .0	.0	0	12.0	19.0	—	—	-	-	209	—	—
E 6	16.0	21.0	13.0	0	12.0	19.0	—	—	-	-	—	—	—
2d. M	0	0	9	0	12.0	19.0	—	—	✓ P	-	128	81	9.0
Do. M 12	0	0	9	0	12.0	19.0	—	—	—	-	—	—	—
Do. E 7	0	0	9	0	12.0	19.0	—	—	off	-	—	—	—
3d. M 6	0	0	0	0	0	19.0	—	—	✓ P	✓ S	64	64	7.1
Do. E 7	0	0	0	0	0	19.0	—	—	off	off	—	—	—
Br. 4th. M 8	0	0	0	0	0	0	—	—	✓ P	✓ S	—	64	7.1
Do. M 12	0	0	0	0	0	0	—	—	—	✓	—	—	—
Do. E 8	15.0	22.0	4.0	0	0	0	—	—	off	off	81	—	—
5th. M 7	15.0	22.0	4.0	0	0	0	—	—	-	✓ S	—	—	—
Do. E 4	1.0	22.0	4.0	0	0	0	—	—	-	off	—	—	—

ck of Singlings.					Stock of X Waters.								
2	3	4	Encreafe of Singlings.	Reduced to X Waters	5	6	7	8	9	10	11	Encreafe of X Waters.	Charge of X Waters.
5	18.5				12.3	15.0	19.1	5.0	17.0	18.5	22.0		
.1	32	10			10	21	33	22	37	31	42		
	0	0	—	—	0	10.	9.1	0	0	0	0		
	0	0	—	—	0	8.	6.	0	0	0	0		
.5	0	0	—	—	0	7.	5.	0	0	0	0		
.5	0	0	—	—	0	7.	5.	0	0	0	0		
.	0	0	21.	7.	0	7.	5.	0	0	0	0		
	0	0	—	—	2.	6.	4.	0	0	0	0		
	0	0	19.	6.3	10	5	4.	0	0	0	0	9.	9.
.5	0	0	—	—	10	5.	0.	0	0	0	0		
3.	0	0	—	—	10	5.	0.	4.	0	0	0	8.5	8.5
3.	0	0	19.	6.	10	5.	0.	6.3	0	0	0		
0	0	0	—	—	10	3.	0.	7.5	0	0	0		
0	0	0	—	—	10	0.	0.	9.8	0	0	0	7.1	7.1

A Table of Licences at Fairs and Patrons.

No. Gall.	Lyc. at s.	d.	No. Gall.	Lyc. at s.	d.	No. Gall.	Lyc. at s.	d.
1	0	—⅛	35	1	1⅛	69	2	1⅛
2	0	—¼	36	1	1½	70	2	2¼
3	0	1⅛	37	1	1⅞	71	2	2⅝
4	0	1½	38	1	2¼	72	2	3
5	0	1⅞	39	1	2⅝	73	2	3⅛
6	0	2¼	40	1	3	74	2	3⅓
7	0	2⅝	41	1	3⅛	75	2	4⅛
8	0	3	42	1	3¾	76	2	4
9	0	3⅛	43	1	4⅛	77	2	4⅞
10	0	3¼	44	1	4½	78	2	5¼
11	0	4⅛	45	1	4⅞	79	2	5⅝
12	0	4½	46	1	5¼	80	2	6
13	0	4⅞	47	1	5⅝	81	2	6⅜
14	0	5¼	48	1	6	82	2	6¾
15	0	5⅝	49	1	6⅜	83	2	7⅛
16	0	6	50	1	6¾	84	2	7½
17	0	6⅜	51	1	7⅛	85	2	7⅞
18	0	6¼	52	1	7½	86	2	8¼
19	0	7⅛	53	1	7⅞	87	2	8⅝
20	0	7½	54	1	8¼	88	2	9
21	0	7⅞	55	1	8⅝	89	2	9⅜
22	0	8¼	56	1	9	90	2	9¾
23	0	8⅝	57	1	9⅜	91	2	10⅛
24	0	9	58	1	9¾	92	2	10½
25	0	9⅜	59	1	10⅛	93	2	10⅞
26	0	9¼	60	1	10½	94	2	11¼
27	0	10⅛	61	1	10⅞	95	2	11⅝
28	0	10½	62	1	11¼	96	3	—
29	0	10⅞	63	1	11⅝	97	3	—⅜
30	0	11¼	64	2	—	98	3	—¼
31	1	11¾	65	2	—⅜	99	3	1⅛
32	1	—	66	2	—¾	100	3	1½
33	0	—⅛	67	2	1⅛			
34	0	—¾	68	2	1½			

A TABLE of the Segments of a Circle, whose Area is Unity, the Diameter (viz. 1.128378) being divided into 100 equal parts.

V S	Segments	V S	Segments	V S	Segments	V S	Segments
1	.001693	99	.998307	26	.206599	74	.793401
2	.004771	98	.995229	27	.217838	73	.782162
3	.008741	97	.991259	28	.229208	72	.770792
4	.013417	96	.986583	29	.240703	71	.759297
5	.018693	95	.981307	30	.252315	70	.747685
6	.024496	94	.975504	31	.264039	69	.735961
7	.030772	93	.969228	32	.275868	68	.724132
8	.037478	92	.962522	33	.287795	67	.712205
9	.044578	91	.955422	34	.299814	66	.700186
10	.052044	90	.947956	35	.311920	65	.688080
11	.059849	89	.940151	36	.324103	64	.675897
12	.067972	88	.932028	37	.336363	63	.663637
13	.076393	87	.923607	38	.348691	62	.651309
14	.085094	86	.914906	39	.361082	61	.638918
15	.094060	85	.905940	40	.373530	60	.626470
16	.103275	84	.896725	41	.386030	59	.613970
17	.112727	83	.887273	42	.398576	58	.601424
18	.122402	82	.877598	43	.411165	57	.599935
19	.132289	81	.867711	44	.423789	56	.576211
20	.142378	80	.857622	45	.436444	55	.563556
21	.152658	79	.847342	46	.449124	54	.550876
22	.163119	78	.836881	47	.461826	53	.538174
23	.173752	77	.826248	48	.474543	52	.525457
24	.184549	76	.815451	49	.487266	51	.512734
25	.195501	75	.804499	50	.500000	50	.500000

A TABLE shewing the Areas of Circles from $\frac{1}{10}$ to Ten Inches Diameter.

Circles Areas in Gallons and Parts.

Diamt.	.0	.1	.2	.3	.4
0	.000000	.000036	.000144	.000324	.000577
1	.003609	.004367	.005197	.006100	.007074
2	.014437	.015917	.017469	.019093	.020790
3	.032484	.034686	.036960	.039306	.041724
4	.057750	.060673	.063670	.066737	.069877
5	.090234	.093880	.097597	.101387	.105249
6	.129937	.134304	.138744	.143256	.147840
7	.176859	.181948	.187110	.192343	.197649
8	.231000	.236810	.242694	.248649	.254677
9	.292358	.298892	.305497	.312174	.318924
10	.360936	.368191	.375518	.382917	.390389

Diamt.	.5	.6	.7	.8	.9
0	.000902	.001299	.001768	.002310	.002923
1	.008121	.009240	.010431	.011694	.013030
2	.022558	.024400	.026312	.028297	.030354
3	.044214	.046777	.049412	.052119	.054898
4	.073090	.076374	.079731	.083160	.086661
5	.109182	.113190	.117268	.121419	.125642
6	.152496	.157224	.162024	.166897	.171842
7	.203027	.208477	.214000	.219594	.225260
8	.260777	.266949	.273193	.279509	.285898
9	.325745	.332639	.339605	.346643	.353754
10	.397932	.405548	.413236	.420996	.428828

A

TABLE,

SHEWING THE

Contents of Cylinders

IN

GALLONS

AND

CENTESIMAL PARTS,

FROM

TEN TO FORTY-FIVE INCHES DIAMETER;

AND FROM

ONE TO THIRTY INCHES DEEP.

TABLES

CALCULATED FOR THE USE

OF THE

REVENUE OFFICERS

OF

Ireland.

CONTAINING,

I. New and correct Tables of Cylinders from 10 Inches to 45 Inches Diameter, with their use.

II. A Table shewing the Areas of Squares in Gallons and Decimal Parts, calculated to every tenth part and quarter of an Inch of the side, from 1 to 100 Inches.

III. A Table of Allowance to common Brewers of two Gallons in 22 for Ale, and of 2½ Gallons in 23 for Beer X and VI.

IV. New and correct Money Tables for Ale and Small Beer, in which the hereditary Revenue, and additional Duties are calculated and proportioned to the Gallon of 217.6 Cubic Inches; as lately ordered by the Right Honorable and Honorable the Commissioners of His Majesty's Revenue of Ireland.

V. A new and correct Money Table for Strong Waters at 2 Pence, 8 Pence, and 10 Pence per Gallon, from 1 to 2000 Gallons.

By GEORGE M'GREGOR, PHILOMATH.

To the Reader.

MANY Gentlemen having complained of the inconvenience ariſing from the ſize of BALLARD's Treatiſe on Gauging, as well as of the incorrectneſs of that work, ſince its firſt publication, wherein are inſerted a number of articles, not only unneceſſary to the acquiſition of that ſcience, but tireſome and diſguſting to the reader; the Editor has, by the advice of ſeveral Gentlemen in the Revenue, given the Public an accurate edition of the eſſential parts of Ballard, together with M'Gregor's, and other additional Tables entirely new, which, being the ſubſtance of the lateſt improvements in that uſeful branch, muſt render this work the moſt perfect in its kind of any hitherto offered to the world, on ſo intereſting a ſubject.

With reſpect to the preſent, he begs leave to obſerve, that the purchaſers will receive a double benefit, as the work is printed on fine paper, very correct, and takes up little room in the pocket.

OF

OF THE

Table of Cylinders.

THE uſe of the following Table is to ſhew the content of any Cylindrical Veſſel in Gallons, the Diameter and Depth being given.

1st *Example.*

Suppoſe the Diameter of a Cylinder to be 29.6, and the Depth 24 Inches, how many Gallons doth it contain?

At the head of the Table, find the Diameter 29, and in the firſt column 24 the Depth, againſt which, and under .6 the remaining part of the Diameter, you have 75.91 Gallons, the content of the Cylinder.

2d *Example.*

Suppoſe the Liquor in this Veſſel was 19.8 Inches deep.	
Againſt 19 Inches you have — — —	60.09
Againſt 8 Inches deep you have 25.30, remove the point one place towards the left-hand it will give the content at 8 deep, *viz.* —	2.53
Content at 19.8 deep —	62.62

Note. If the Diameter of a Cylinder exceeds 45 Inches, find it in the firſt column of the Table of Circles Areas, and againſt the whole Inches of the Diameter, and under the tenths, if any be, you have the content at one Inch deep; which multiplied by the Depth, gives the whole content in Gallons and Parts.

Note. The Area correſpondent to the Semi-Diameter of any circle is equal to $\frac{1}{4}$ of the Area of the whole circle; therefore if the Diameter of a circle be more than 140, and leſs than 280 Inches, find the Area anſwering to the Semi-Diameter thereof in the following Table, which multiplied by 4, gives the Area or content upon an Inch of the whole circle.

The like may be obſerved in relation to the Table of the Areas of Squares.

10 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	0.36	0.36	0.37	0.38	0.39	0.39	0.40	0.41	0.42	0.42
2	0.72	0.73	0.75	0.76	0.78	0.79	0.81	0.82	0.84	0.85
3	1.08	1.10	1.12	1.14	1.17	1.19	1.21	1.23	1.26	1.28
4	1.44	1.47	1.50	1.53	1.56	1.59	1.62	1.65	1.68	1.71
5	1.80	1.84	1.87	1.91	1.95	1.99	2.03	2.06	2.10	2.14
6	2.16	2.20	2.25	2.29	2.34	2.38	2.43	2.47	2.52	2.57
7	2.52	2.57	2.62	2.68	2.73	2.78	2.84	2.89	2.94	3.00
8	2.88	2.94	3.00	3.06	3.12	3.18	3.24	3.30	3.36	3.43
9	3.24	3.31	3.37	3.44	3.51	3.58	3.65	3.71	3.78	3.86
10	3.61	3.68	3.75	3 83	3.90	3.98	4.06	4.13	4.21	4.29
11	3.97	4.04	4.12	4.21	4.29	4.37	4.46	4 54	4.63	4 71
12	4.33	4.41	4.50	4.59	4.68	4.77	4.87	4.95	5.05	5.14
13	4.69	4.78	4.87	4.97	5.07	5.17	5.27	5.36	5 47	5.57
14	5.05	5.15	5.25	5.36	5.46	5.57	5.68	5.78	5.89	6.00
15	5.41	5.52	5.62	5.74	5.85	5.97	6.09	6.19	6.31	6.43
16	5.77	5.88	6.00	6.12	6.24	6.36	6.49	6.60	6.73	6.86
17	6.13	6.25	6.37	6.51	6.63	6.76	6.90	7.02	7.15	7.29
18	6.49	6.62	6.75	6.89	7.02	7.16	7.30	7.43	7.57	7.72
19	6.85	6.99	7.12	7.27	7.41	7.56	7 71	7.84	7.99	8.15
20	7.22	7.36	7.50	7.66	7.80	7.96	8.12	8.26	8.42	8.58
21	7.58	7.72	7.87	8.04	8.19	8.35	8.52	8.67	8.84	9.00
22	7.94	8.09	8.24	8.42	8.58	8.75	8.93	9.08	9.26	9.43
23	8.30	8.46	8.62	8.89	8.97	9.15	9.33	9.49	9.68	9.86
24	8.66	8.83	9.03	9.19	9.36	9.55	9.74	9.91	10.10	10.29
25	9.02	9.20	9.37	9.57	9.75	9.95	10.15	10.32	10.52	10.72
26	9.38	9.56	9.75	9.95	10.14	10.34	10.55	10.75	10.94	11.15
27	9.74	9.93	10.12	10.34	10.53	10.74	10.96	11.15	11.36	11.58
28	10.10	10.30	10.50	10.72	10.92	11.14	11.36	11 56	11.78	12.01
29	10.46	10.67	10.87	11.10	11.31	11.54	11.77	11.97	12.20	12.44
30	10.83	11.04	11.25	11.49	11.70	11.94	12.18	12.39	12.63	12.87

11 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	0.43	0.44	0.45	0.46	0.46	0.47	0.48	0.49	0.50	0.51
2	0.87	0.89	0.90	0.92	0.93	0.95	0.97	0.98	1.00	1.02
3	1.31	1.33	1.35	1.38	1.40	1.43	1.45	1.48	1.50	1.53
4	1.74	1.78	1.81	1.84	1.87	1.90	1.94	1.97	2.00	2.04
5	2.18	2.22	2.26	2.30	2.34	2.38	2.42	2.47	2.51	2.55
6	2.62	2.67	2.71	2.76	2.81	2.86	2.91	2.96	3.01	3.06
7	3.05	3.11	3.17	3.22	3.28	3.33	3.39	3.45	3.51	3.57
8	3.49	3.56	3.62	3.68	3.75	3.81	3 88	3.95	4.01	4.08
9	3.93	4.00	4.07	4.14	4.22	4.29	4.36	4.44	4.51	4.59
10	4.37	4.45	4.53	4.61	4.60	4.77	4.85	4.94	5 02	5.11
11	4.80	4.89	4.98	5.07	5.15	5.24	5.33	5.43	5.52	5.62
12	5.24	5 34	5.43	5.53	5.62	5.72	5.82	5.92	6.02	6.13
13	5.68	5.78	5.88	5.99	6.09	6.20	6.30	6.42	6.52	6.64
14	6.11	6.23	6.34	6.45	6.56	6.67	6.79	6.91	7.02	7.15
15	6.55	6.67	6.79	6.91	7.03	7.15	7.27	7.41	7.53	7.66
16	6.99	7.12	7.24	7 37	7.50	7.63	7.76	7.90	8.03	8.17
17	7.42	7.56	7.70	7.83	7.97	8.10	8.24	8.39	8.53	8.68
18	7.86	8.01	8.15	8.29	8.44	8.58	8.73	8.89	9.03	9.19
19	8.30	8.45	8.60	8.75	8.91	9.06	9.21	9.38	9.53	9.70
20	8.74	8.90	9.06	9.22	9.38	9.54	9.70	9.88	10.04	10.22
21	9.17	9.34	9.51	9.68	9.84	10.01	10.18	10.37	10.54	10.73
22	9.61	9.79	9.96	10.14	10.31	10.49	10.67	10.86	11.04	11.24
23	10.05	10.23	10.41	10.60	10.78	10.97	11.15	11.36	11.54	11.75
24	10.48	10 68	10.87	11.06	11.25	11.44	11.64	11.85	12.04	12.26
25	10.92	11.12	11.32	11.52	11.72	11.92	12.12	12.35	12.55	12.77
26	11.36	11.57	11.77	11.98	12.19	12.40	12.61	12.84	13.05	13.28
27	11.79	12.01	12.23	12.44	12.66	12.87	13.09	13.33	13.55	13.79
28	12.23	12.46	12.68	12.90	13.13	13.35	13.58	13 83	14.05	14.30
29	12.67	12.90	13.13	13.36	13.60	13.83	14.06	14.32	14.55	14.81
30	13.11	13.35	13.59	13.83	14.07	14.31	14.55	14.82	15.06	15.33

12 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	0.52	0.52	0.53	0.54	0.55	0 56	0.57	0.58	0.59	0.60
2	1.04	1.05	1.07	1.09	1.11	1.12	1.14	1.16	1.18	1.20
3	1.56	1.58	1.61	1.63	1.66	1.69	1.71	1.74	1.77	1.80
4	2 08	2.11	2.14	2.18	2.22	2.25	2.29	2.32	2.36	2.40
5	2.60	2.64	2.68	2.73	2.77	2.82	2 86	2.91	2.95	3.00
6	3.12	3.16	3.22	3.27	3.33	3.38	3.43	3.49	3.54	3.60
7	3.64	3.69	3.75	3.82	3.88	3 94	4.01	4.07	4.13	4.20
8	4.16	4.22	4.29	4.36	4.44	4.51	4.58	4.65	4.72	4.80
9	4.68	4.75	4.83	4.91	4 99	5.07	5 15	5.23	5.31	5.40
10	5.20	5.28	5.37	5.46	5.55	5 64	5.73	5.82	5.91	6.00
11	5.72	5.80	5.90	6.00	6.10	6.20	6.30	6.40	6.50	6.60
12	6.24	6.33	6.44	6.55	6.66	6.76	6.87	6.98	7.09	7.20
13	6.76	6.86	6.98	7.09	7.21	7.33	7.44	7.56	7.68	7.80
14	7.28	7.39	7.51	7.64	7.77	7.89	8.02	8.14	8.27	8.40
15	7.80	7.92	8.05	8.19	8.32	8.46	8.59	8.73	8.86	9.00
16	8.32	8.44	8.59	8.73	8.88	9.02	9.16	9.31	9.45	9.60
17	8.84	8.97	9.12	9.28	9.43	9 58	9.74	9 89	10.04	10.20
18	9.36	9.50	9.66	9.82	9.99	10.15	10.31	10.47	10.63	10 80
19	9.88	10.03	10.20	10.37	10.54	10.71	10.88	11.05	11.22	11.40
20	10.40	10.56	10.74	10.92	11.10	11 28	11.46	11.64	11.82	12.00
21	10.92	11.08	11.27	11.46	11.65	11.84	12.03	12.22	12.41	12.60
22	11.44	11.61	11.81	12.01	12.21	12.40	12.60	12.80	13.00	13.20
23	11.96	12 14	12.35	12.55	12.76	12.97	13.17	13.38	13.59	13.80
24	12.48	12.67	12.88	13.10	13.32	13.53	13.75	13 96	14.18	14.40
25	13.00	13.20	13.42	13.65	13.87	14.10	14.32	14.55	14.77	15.00
26	13.52	13.72	13.96	14.19	14.43	14.66	14 89	15.13	15.36	15.60
27	14.04	14.25	14.49	14.74	14.98	15.22	15.47	15.71	15.95	16.20
28	14.56	14.78	15.03	15.28	15.54	15.78	16.04	16.29	16.54	16.80
29	15.08	15.31	15.57	15.83	16.09	16.35	16.61	16.87	17.13	17.40
30	15.60	15.84	16.11	16.38	16.65	16.92	17.19	17.46	17.73	18 00

13 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	0.61	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.68	0.69
2	1.22	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39
3	1.83	1.85	1.88	1.91	1.94	1.97	2.00	2.03	2.06	2.09
4	2.44	2.47	2.51	2.55	2.59	2.63	2.67	2.70	2.74	2.78
5	3.05	3.09	3.14	3.19	3.24	3.29	3.34	3.38	3.43	3.48
6	3.66	3.71	3.77	3.82	3.88	3.94	4.00	4.06	4.12	4.18
7	4.27	4.33	4.40	4.46	4.53	4.60	4.67	4.73	4.80	4.87
8	4.88	4.95	5.03	5.10	5.18	5.26	5.34	5.41	5.49	5.57
9	5.49	5.57	5.66	5.74	5.83	5.92	6.01	6.09	6.18	6.27
10	6.10	6.19	6.29	6.38	6.48	6.58	6.68	6.77	6.87	6.97
11	6.71	6.80	6.91	7.01	7.12	7.23	7.34	7.44	7.55	7.66
12	7.32	7.42	7.54	7.65	7.77	7.89	8.01	8.12	8.24	8.36
13	7.93	8.04	8.17	8.29	8.42	8.55	8.68	8.80	8.93	9.06
14	8.54	8.66	8.80	8.93	9.07	9.21	9.35	9.47	9.61	9.75
15	9.15	9.28	9.43	9.57	9.72	9.87	10.02	10.15	10.30	10.45
16	9.76	9.90	10.06	10.20	10.36	10.52	10.68	10.83	10.99	11.15
17	10.37	10.52	10.69	10.84	11.01	11.18	11.35	11.50	11.67	11.84
18	10.98	11.14	11.32	11.48	11.66	11.84	12.02	12.18	12.36	12.54
19	11.59	11.76	11.95	12.12	12.31	12.50	12.69	12.86	13.05	13.24
20	12.20	12.38	12.58	12.76	12.96	13.16	13.36	13.54	13.74	13.94
21	12.81	12.99	13.20	13.39	13.60	13.81	14.02	14.21	14.42	14.63
22	13.42	13.61	13.83	14.03	14.25	14.47	14.69	14.89	15.11	15.33
23	14.03	14.23	14.46	14.67	14.90	15.13	15.36	15.57	15.80	16.03
24	14.64	14.85	15.09	15.31	15.55	15.79	16.03	16.24	16.48	16.72
25	15.25	15.47	15.72	15.95	16.20	16.45	16.70	16.92	17.17	17.42
26	15.86	16.09	16.35	16.58	16.84	17.10	17.36	17.60	17.86	18.12
27	16.47	16.71	16.98	17.22	17.49	17.76	18.03	18.27	18.54	18.81
28	17.08	17.33	17.61	17.86	18.14	18.42	18.70	18.95	19.23	19.51
29	17.69	17.95	18.24	18.50	18.79	19.08	19.37	19.63	19.92	20.21
30	18.30	18.57	18.87	19.14	19.44	19.74	20.04	20.31	20.61	20.91

14 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	0.70	0.71	0.72	0.73	0.74	0.75	0.76	0.78	0.79	0.80
2	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.56	1.58	1.60
3	2.12	2.15	2.18	2.21	2.24	2.27	2.30	2.34	2.37	2.40
4	2.82	2.86	2.91	2.95	2.99	3.03	3.07	3.12	3.16	3.20
5	3.53	3.58	3.64	3.69	3.74	3.79	3.84	3.90	3.95	4.00
6	4 24	4.30	4.36	4.42	4.48	4.55	4.61	4.68	4.74	4.80
7	4.94	5.01	5.09	5.16	5.23	5.31	5.38	5.46	5.53	5.60
8	5.65	5.73	5.82	5.90	5.98	6.07	6.15	6 24	6.32	6.40
9	6.36	6.45	6.55	6.64	6 73	6.83	6.92	7.02	7.11	7.20
10	7.07	7.17	7.28	7.38	7.48	7.59	7.69	7.80	7.91	8.01
11	7.77	7.88	8.00	8.11	8.22	8.34	8.45	8.58	8.70	8.81
12	8.48	8.60	8.73	8.85	8.97	9.10	9.22	9.36	9.49	9.61
13	9.19	9.32	9.46	9.59	9.72	9.86	9 99	10.14	10.28	10.41
14	9.89	10.03	10.19	10.33	10.47	10.62	10.76	10.92	11.07	11.21
15	10.60	10.75	10.92	11.07	11.22	11.38	11.53	11.70	11.86	12.01
16	11.31	11.47	11.64	11.80	11.96	12 14	12.30	12.48	12.65	12.81
17	12.01	12.18	12.37	12.54	12.71	12.90	13.07	13.26	13.44	13 61
18	12.72	12.90	13.10	13.28	13.46	13 66	13.84	14.04	14.23	14.41
19	13.43	13.62	13.83	14.02	14.21	14.42	14 61	14.82	15.02	15.21
20	14.14	14.34	14.56	14.76	14.96	15.18	15.38	15.60	15.82	16.02
21	14.84	15.05	15.28	15.49	15.70	15.93	16.14	16.38	16.61	16.82
22	15.55	15.77	16.01	16.23	16.45	16.69	16.91	17.16	17.40	17.62
23	16.26	16.49	16.74	16.97	17.20	17.45	17.68	17.94	18.19	18.42
24	16 96	17.20	17.47	17.71	17.95	18.21	18.45	18.72	18.98	19.22
25	17.67	17.92	18.20	18.45	18.70	18.97	19.22	19.50	19.77	20.02
26	18.38	18.64	18.92	19.18	19.44	19.73	19.99	20.28	20.56	20.82
27	19.08	19.35	19.65	19.92	20.19	20.40	20.76	21.06	21.35	21.62
28	19.79	20.07	20.38	20.66	20.94	21.25	21.53	21.84	22.14	22.42
29	20.50	20.79	21.11	21.40	21.69	22.01	22.30	22.62	22.93	23.22
30	21.21	21.51	21.84	22.14	22.44	22.77	23.07	23.40	23.73	24.03

15 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	0.81	0.82	0.83	0.84	0 85	0.86	0.87	0.89	0.90	0.91
2	1.62	1.64	1.66	1.69	1.71	1.73	1.75	1.78	1.80	1.82
3	2.43	2.46	2.50	2.53	2.56	2.60	2.63	2.67	2.70	2.73
4	3.24	3.29	3.33	3.38	3.42	3 46	3.51	3.56	3.60	3.64
5	4.06	4.11	4.17	4 22	4.28	4.33	4.39	4 45	4.50	4.56
6	4.87	4.93	5.00	5.07	5.13	5.20	5.26	5.34	5.40	5.47
7	5.68	5.76	5.83	5 91	5.99	6.06	6.14	6 23	6.30	6.38
8	6.49	6.58	6 67	6.76	6.84	6.93	7.02	7.12	7.20	7.29
9	7.30	7.40	7.50	7.60	7.70	7 80	7.90	8.01	8.10	8.20
10	8.12	8.23	8.34	8.45	8.56	8.67	8.78	8.90	9.01	9.12
11	8.93	9.05	9.17	9.29	9.41	9.53	9.65	9.79	9.91	10.03
12	9.74	9.87	0 00	10.14	10.27	10.40	10.53	10.68	10.81	10.94
13	10.55	10.69	10.84	10.98	11.12	11.27	11.41	11.57	11.71	11.85
14	11.36	11.52	11.67	11.83	11.98	12 13	12 29	12.46	12.61	12.76
15	12.18	12.34	12.50	12.67	12 84	13.00	13.17	13.35	13.51	13.68
16	12.99	13.16	13.34	13.52	13 69	13.87	14.04	14.24	14.41	14.59
17	13.80	13.99	14 17	14.36	14.55	14.73	14.92	15 13	15.31	15.50
18	14.61	14.81	15.01	15.21	15.40	15.60	15.80	16.02	16.21	16.41
19	15.42	15.63	15.84	16.05	16.26	16.47	16.68	16.91	17.11	17.32
20	16.24	16.46	16.68	16.90	17.12	17.34	17.56	17.80	18.02	18.24
21	17.05	17.28	17.51	17.74	17.97	18.20	18.43	18.69	18.92	19.15
22	17 86	18.10	18.34	18.59	18.83	19.07	19.31	19.58	19.82	20.06
23	18.67	18.92	19.18	19.43	19.68	19.94	20.19	20.47	20.72	20.97
24	19.48	19.75	20.01	20.28	20.54	20.80	21.07	21.36	21.62	21.88
25	20.30	20.57	20.85	21.12	21.40	21.67	21.95	22.25	22.52	22.80
26	21.11	21.39	21 68	21 97	22.25	22.54	22.82	23.14	23.42	23.71
27	21.92	22.22	22.51	22.81	23.11	23.40	23.70	24.03	24 32	24.62
28	22.73	23.04	23.35	23.66	23.96	24.27	24.58	24.92	25.22	25.53
29	23.54	23.86	24.18	24.50	24 82	25.14	25.46	25.81	26.12	26.44
30	24.36	24.69	25.02	25.35	25.68	26.01	26.34	26.70	27.03	27.36

16 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	0.92	0.93	0.94	0.95	0.97	0.98	0.99	1.00	1.01	1.03
2	1.84	1.87	1.89	1.91	1.94	1.96	1.99	2.01	2.03	2.06
3	2.77	2.80	2.84	2.87	2.91	2.94	2.98	3.02	3.05	3.09
4	3.69	3.74	3.78	3.83	3.88	3.93	3.98	4.02	4.07	4.12
5	4.62	4.67	4.73	4.79	4.85	4.91	4.97	5.03	5.09	5.15
6	5.54	5.61	5.68	5.75	5.82	5.89	5.97	6.04	6.11	6.18
7	6.46	6.54	6.62	6.71	6.79	6.88	6.96	7.04	7.13	7.21
8	7.39	7.48	7.57	7.67	7.76	7.86	7.96	8.05	8.15	8.24
9	8.31	8.41	8.52	8.63	8.73	8.84	8.95	9.05	9.17	9.27
10	9.24	9.35	9.47	9.59	9.71	9.83	9.95	10.07	10.19	10.31
11	10.16	10.28	10.41	10.54	10.68	10.81	10.94	11.07	11.20	11.34
12	11.08	11.22	11.36	11.50	11.65	11.79	11.94	12.08	12.22	12.37
13	12.01	12.15	12.31	12.46	12.62	12.77	12.93	13.09	13.24	13.40
14	12.93	13.09	13.25	13.42	13.59	13.76	13.93	14.09	4.26	14.43
15	13.86	14.02	14.20	14.38	14.56	14.74	14.92	15.10	15.28	15.46
16	14.78	14.96	15.15	15.34	15.53	15.72	15.92	16.11	16.30	16.49
17	15.70	15.89	16.09	16.30	16.50	16.71	16.91	17.11	17.32	17.52
18	16.63	16.83	17.04	17.26	17.47	17.69	17.91	18.12	18.34	18.55
19	17.55	17.76	17.99	18.22	18.44	18.67	18.90	19.13	19.36	19.58
20	18.48	18.70	18.94	19.18	19.42	19.66	19.90	20.14	20.38	20.62
21	19.40	19.63	19.88	20.13	20.39	20.64	20.89	21.14	21.39	21.65
22	20.32	20.57	20.83	21.09	21.36	21.62	21.89	22.15	22.41	22.68
23	21.25	21.50	21.78	22.05	22.33	22.60	22.88	23.16	23.43	23.71
24	22.17	22.44	22.72	23.01	23.30	23.59	23.88	24.16	24.45	24.74
25	23.10	23.37	23.67	23.97	24.27	24.57	24.87	25.17	25.47	25.77
26	24.02	24.31	24.61	24.93	25.24	25.55	25.87	26.18	26.49	26.80
27	24.94	25.24	25.56	25.89	26.21	26.54	26.86	27.18	27.51	27.83
28	25.87	26.18	26.51	26.85	27.18	27.52	27.86	28.19	28.53	28.86
29	26.79	27.11	27.46	27.81	28.15	28.50	28.85	29.20	29.55	29.89
30	27.72	28.05	28.41	28.77	29.13	29.49	29.85	30.21	30.57	30.93

17 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	1.04	1.05	1.06	1.08	1.09	1.10	1.11	1.13	1.14	1.15
2	2.08	2.11	2.13	2.16	2.18	2.21	2.23	2.26	2.28	2.31
3	3.12	3.16	3.20	3.24	3.27	3.31	3.35	3.39	3.42	3.46
4	4.17	4.22	4.27	4.32	4.37	4.42	4.47	4.52	4.57	4.62
5	5.21	5.27	5.34	5.40	5.46	5.52	5.59	5.65	5.71	5.78
6	6.25	6.33	6.40	6.48	6.55	6.63	6.70	6.78	6.85	6.93
7	7.30	7.38	7.47	7.56	7.65	7.73	7.82	7.91	8.00	8.09
8	8.34	8.44	8.54	8.64	8.74	8.84	8.94	9.04	9.14	9.24
9	9.38	9.49	9.61	9 72	9.83	9.94	10 06	10.17	10.28	10.40
10	10.43	10.55	10.68	10.80	10.93	11.05	11.18	11.31	11.43	11.56
11	11.47	11.60	11.74	11.88	12.02	12.15	12.29	12.44	12.57	12.71
12	12.51	12.66	12.81	12.96	13.11	13.26	13.41	13.57	13.71	13.87
13	13.55	13.71	13.88	14.04	14.20	14.36	14.53	14.70	14.85	15.02
14	14.60	14.77	14.95	15.12	15.30	15.47	15.65	15.83	16.00	16.18
15	15.64	15.82	16.02	16.20	16.39	16.57	16.77	16.96	17.14	17.34
16	16.68	16.88	17.08	17.28	17.48	17.68	17.88	18.09	18.28	18.49
17	17.73	17.93	18.15	18.38	18.58	18.78	19.00	19.22	19.43	19.65
18	18.77	18.99	19.22	19.44	19.67	19.89	20.12	20.35	20.57	20.80
19	19.81	20.04	20.29	20.52	20.76	20.99	21.24	21.48	21.71	21.96
20	20.86	21.10	21.36	21.60	21.86	22.10	22.36	22.62	22.86	23.12
21	21.90	22.15	22.42	22.68	22.95	23.20	23.47	23.75	24.00	24.27
22	22.94	23.21	23.49	23.76	24.04	24.31	24.59	24.88	25.14	25.43
23	23.98	24.26	24.56	24.84	25.13	25.41	25.71	26.01	26.28	26.58
24	25.03	25.32	25.63	25.92	26.23	26.52	26.83	27.14	27.43	27.74
25	26.07	26.37	26.70	27.00	27.32	27 62	27.95	28.27	28.57	28.90
26	27.11	27.43	27.76	28.08	28.41	28.73	29.06	29.40	29.71	30.05
27	28.16	28.48	28.83	29.16	29.51	29.83	30.18	30.53	30.86	31.21
28	29.20	29.54	29.90	30.24	30.60	30.94	31.30	31.66	32.00	32.36
29	30.24	30.59	30.97	31.32	31.69	32.04	32.42	32.79	33.14	33.52
30	31.29	31.65	32.04	32.40	32.79	33.15	33.54	33.93	34.29	34.68

18 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	1.16	1.18	1.19	1.20	1.22	1.23	1.24	1.26	1.27	1.28
2	2.33	2.36	2.39	2.41	2.44	2.47	2.49	2.52	2.55	2.57
3	3.50	3.54	3.58	3.62	3.66	3.70	3.74	3.78	3.82	3.86
4	4.67	4.72	4.78	4.83	4.88	4.94	4.99	5.04	5.10	5.15
5	5.84	5.91	5.97	6.04	6.11	6.17	6 24	6.31	6.38	6.44
6	7.01	7.09	7.17	7.25	7.33	7.41	7.49	7.57	7.65	7.73
7	8.18	8.27	8.36	8.46	8.55	8.64	8.74	8.83	8.93	9.02
8	9.35	9.45	9.56	9.67	9.77	9.88	9.99	10.09	10.20	10.31
9	10.52	10.63	10.75	10.88	10 99	11.11	11.24	11.35	11.48	11.60
10	11.69	11.82	11.95	12.09	12.22	12.35	12.49	12.62	12.76	12.89
11	12.85	13.00	13.14	13.29	13.44	13.58	13.73	13.88	14.03	14.17
12	14.02	14.18	14.34	14.50	14.66	14.82	14.98	15.14	15.31	15.46
13	15.19	15.36	15.53	15.71	15.88	16.05	16.23	16.40	16.58	16.75
14	16.36	16.54	16.73	16.92	17.10	17.29	17.48	17.66	17.86	18.04
15	17.53	17.73	17.92	18.13	18.33	18.52	18.73	18.93	19.14	19.33
16	18.70	18.91	19.12	19.34	19.55	19.76	19.98	20.19	20.41	20.62
17	19.87	20.09	20.31	20.55	20.77	20.99	21.23	21.45	21.69	21.91
18	21.04	21.27	21.51	21.76	21.99	22.23	22.48	22.71	22.96	23.20
19	22.21	22.45	22.70	22.97	23.21	23.46	23.73	23.97	24.24	24.49
20	23.38	23.64	23.90	24.18	24.44	24.70	24.98	25.24	25.52	25.78
21	24.54	24.82	25.09	25.38	25.66	25.93	26.22	26.50	26.79	27.06
22	25.71	26.00	26.29	26.59	26.88	27.17	27.47	27.76	28.07	28.35
23	26.88	27.18	27.48	27.80	28.10	28.40	28.72	29.02	29.34	29.64
24	28.05	28.36	28.68	29.01	29.32	29.64	29.97	30.28	30.62	30.93
25	29.22	29.55	29.87	30.22	30.55	30.87	31.22	31.55	31.90	32.22
26	30.39	30.73	31.07	31.43	31.77	32.11	32.47	32.81	33.17	33.51
27	31.56	31.91	32.26	32.64	32.99	33.34	33.72	34.07	34.45	34.80
28	32.73	33.09	33.46	33.85	34.21	34.58	34.97	35.33	35.72	36.09
29	33.90	34.27	34.65	35.06	35.43	35.81	36.22	36.59	37.00	37.38
30	35.07	35 46	35.85	36.27	36.66	37.05	37.47	37.86	38.28	38 67

19 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	1.30	1.31	1.33	1.34	1.35	1.37	1.38	1.40	1.41	1.42
2	2.60	2.63	2.66	2.68	2.71	2.74	2.77	2.80	2.83	2.85
3	3.90	3.95	3.99	4.03	4 07	4.11	4.15	4.20	4.24	4.28
4	5.21	5.26	5.32	5.37	5.43	5.48	5.54	5.60	5.66	5.71
5	6 51	6.58	6.65	6.72	6.79	6 86	6.93	7.00	7.07	7.14
6	7.81	7.90	7.98	8 06	8.14	8.23	8.31	8.40	8.49	8.57
7	9.12	9.21	9.31	9.40	9.50	9.60	9.70	9.80	9.90	10.00
8	10.42	10.53	10.64	10.75	10.86	10.97	11.08	11.20	11.32	11.43
9	11.72	11.85	11.97	12.09	12 22	12.34	12.47	12.60	12.73	12.86
10	13.03	13.17	13.30	13.44	13.58	13.72	13.86	14.01	14.15	14.29
11	14.33	14.48	14.63	14.78	14.93	15.09	15.24	15.41	15.56	15.71
12	15.63	15.80	15.96	16.12	16.29	16.46	16.63	16.81	16.98	17.14
13	16.93	17.12	17.29	17.47	17.65	17.83	18.01	18.21	18.39	18.57
14	18.24	18.43	18.62	18.81	19.01	19.20	19.40	19.61	19.81	20.00
15	19.54	19 75	19.95	20.16	20.37	20.58	20.79	21.01	21.22	21.43
16	20.84	21.07	21.28	21.50	21.72	21.95	22.17	22.41	22.64	22.86
17	22.15	22.38	22.61	22.84	23.08	23.32	23.56	23.81	24.05	24.29
18	23.45	23.70	23.94	24.19	24.44	24.69	24.94	25.21	25 47	25.72
19	24.75	25.02	25.27	25.53	25.80	26.06	26.33	26.61	26.88	27.15
20	26.06	26.34	26.60	26 88	27.16	27.44	27.72	28.02	28.30	28.58
21	27.36	27.65	27.93	28.22	28.51	28.81	29.10	29.42	29.71	30.00
22	28.66	28.97	29.26	29.56	29.87	30.18	30.49	30.82	31.13	31.43
23	29.96	30 29	30 59	30.91	31.23	31.55	31.87	32.22	32.54	32.86
24	31.27	31.60	31.92	32.25	32.59	32.92	33.26	33.62	33 96	34.29
25	32.57	32.92	33.25	33 60	33.95	34.30	34.65	35.02	35.37	35.72
26	33.87	34.24	34.58	34.94	35.30	35 67	36.03	36.42	36.79	37.15
27	35.18	35.55	35.91	36.28	36.66	37 04	37.42	37.82	38.20	38.58
28	36.48	36.87	37.24	37.63	38.02	38.41	38.80	39.22	39.62	40.01
29	37.78	38.19	38.57	38.97	39.38	39.78	40.19	40.62	41.03	41.44
30	39.09	39.50	39.90	40.32	40.74	41.16	41.58	42.03	42.45	42.87

20 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	1.43	1.45	1.47	1.48	1.50	1.51	1.53	1.54	1.56	1.57
2	2.88	2.91	2.94	2.97	3.00	3.03	3.06	3.09	3.12	3.15
3	4.33	4.37	4.41	4.46	4.50	4.55	4.59	4.64	4.68	4.72
4	5.77	5.83	5.89	5.94	6.00	6.06	6.12	6.18	6.24	6.30
5	7.22	7.29	7.36	7.43	7.51	7.58	7.66	7.73	7.81	7 88
6	8.66	8.74	8.83	8.92	9.01	9.10	9.19	9.28	9.37	9.45
7	10.10	10.20	10.31	10.40	10.51	10.61	10.72	10.82	10.93	11.03
8	11.55	11.66	11.78	11.89	12.01	12.13	12.25	12.37	12.49	12.60
9	12.99	13.12	13.25	13.38	13.51	13.65	13.78	13.92	14.05	14.18
10	14.44	14.58	14.73	14.87	15.02	15.17	15.32	15.47	15.62	15.76
11	15.88	16.03	16.20	16.35	16.52	16.68	16 85	17.01	17.18	17.33
12	17.32	17.49	17.67	17.84	18.02	18.20	18.38	18.56	18.74	18.91
13	18 77	18.95	19.14	19 33	19.52	19.72	19.91	20.11	20.30	20.48
14	20.21	20.41	20.62	20.81	21.02	21.23	21.44	21.65	21,86	22.06
15	21.66	21.87	22.09	22.30	22.53	22.75	22.98	23.20	23.43	23.64
16	23.10	23.32	23.56	23.79	24.03	24.27	24.51	24.75	24.99	25.21
17	24.54	24.78	25.04	25.27	25.53	25.78	26.04	26.29	26.55	26.79
18	25.99	26.24	26.51	26.76	27.03	27.30	27.57	27.84	28.11	28.36
19	27.43	27.70	27.98	28.25	28.53	28.82	29.10	29.39	29.67	29.94
20	28.88	29.16	29.46	29 74	30.04	30.34	30.64	30.94	31.24	31.52
21	,0.32	30.61	30.93	31.22	31.54	31.85	32.17	;2.48	32.80	33.09
22	,1.76	32.07	32.40	32.71	33.04	33.37	33.70	34.03	34.36	34.67
23	33.21	33.53	33.87	34.20	34.54	34 89	35.23	35.58	35.92	36.24
24	34.65	34.99	35.35	35.68	36.04	36.40	36.76	37.12	37.48	37.82
25	36.10	36.45	36.82	37.17	37.55	37.92	38.30	38.67	39.05	39.40
26	37.54	37.90	38 29	38.66	39.05	39 44	39.83	40.22	40.61	40.97
27	38.98	39.36	39.77	40.14	40.55	40 95	41.36	41.79	42.17	42.55
28	40.43	40.82	41.24	41.63	42.05	42.47	42.89	43.31	43.73	44.12
29	41.87	42.28	42.71	43.12	43.55	43.99	44.42	44.86	45.29	45.70
30	43.32	43.74	44.19	44.61	45.06	45 51	45.96	46.41	46.86	47.28

21 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	1.59	1.60	1.62	1.63	1.65	1.66	1.68	1.70	1.71	1.73
2	3.18	3.21	3.24	3.27	3.30	3.33	3.36	3.40	3.43	3.46
3	4.77	4.82	4.86	4.91	4.95	5.00	5.05	5.10	5.14	5.19
4	6.36	6.42	6.48	6.54	6.61	6.67	6.73	6.80	6.86	6 92
5	7.96	8.03	8.11	8.18	8.26	8.34	8.42	8.50	8.57	8 65
6	9.55	9.64	9.73	9.82	9 91	10.00	10.10	10.20	10.29	10.38
7	11.14	11.24	11.35	11.45	11.57	11.67	11.78	11.90	12.00	12 11
8	12.73	12.85	12.97	13.09	13.22	13 34	13.47	13.60	13.72	13.84
9	14.32	14.46	14.59	14.73	14.87	15.01	15.15	15.30	15.43	15.57
10	15.92	16.07	16.22	16.37	16.53	16.68	16.84	17.00	17 15	17 31
11	17.51	17.67	17.84	18.00	18.18	18.34	18 52	18.70	18 86	19.04
12	19.10	19.28	19 46	19.64	19.83	20.01	20.20	20 40	20.58	20.77
13	20.69	20.89	21.08	21.28	21.48	21.68	21.89	22.10	22.29	22.50
14	22.28	22.49	22.70	22.91	23.14	23.35	23.57	23 80	24.01	24.23
15	23.88	24.10	24.33	24.55	24.79	25.02	25.26	25.50	25 72	25 96
16	25.47	25.71	25.95	26.19	26.44	26.68	26.94	27.20	27.44	27.69
17	27.06	27.31	27.58	27.82	28.10	28.35	28.62	28.90	29.15	29 42
18	28.65	28.92	29.19	29.46	29.75	30.02	30.31	30.60	30.87	31.15
19	30.24	30.53	30.81	31.10	31.40	31.69	31.99	32.30	32.58	32.88
20	31.84	32.14	32.44	32.74	33.06	33.36	33.68	34.00	34.30	34.62
21	33 43	33.74	34.06	34.37	34.71	35.02	35.36	35.70	36.01	36 31
22	35.02	35.35	35.68	36.01	36.36	36.69	37.04	37 40	37 73	38 08
23	36.61	36.96	37.30	37.65	38.01	38.36	38.73	39 10	39.44	39.81
24	38.20	38.56	38.92	39.28	39.67	40.03	40.41	40.80	41.16	41.54
25	39.80	40.17	40.55	40.92	41.32	41.70	42.10	42.50	42.87	43.27
26	41.39	41.78	42.17	42.56	42.97	43.36	43.78	44.20	44.59	45.00
27	42.98	43.38	43.79	44.19	44.63	45.03	45.46	45.90	46 30	46 73
28	44.57	44.99	45.41	45.83	46.28	46.70	47.15	47.60	48.02	48 46
29	46.16	46 60	47.03	47.47	47.93	48.37	48.83	49.30	49.73	50.19
30	47.76	48.21	48.66	49.11	49.59	50.04	50 52	51.00	51.45	51.93

22 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	1.74	1.76	1.77	1.79	1.81	1.82	1.84	1.86	1.87	1.89
2	3.49	3.52	3.55	3.59	3.62	3.65	3.68	3.72	3.75	3.78
3	5.24	5.28	5.33	5.38	5.43	5.48	5.52	5.58	5.62	5.67
4	6.98	7.05	7.11	7.18	7.24	7.30	7.37	7.44	7.50	7.57
5	8.73	8.81	8.89	8.97	9.05	9.13	9.21	9.30	9.38	9.46
6	10.48	10.57	10.67	10.77	10.86	10.96	11.05	11.16	11.25	11.35
7	12.22	12.34	12.45	12 56	12.67	12.78	12.90	13.02	13.13	13.25
8	13.97	14.10	14.23	14.36	14.48	14.61	14.74	14.88	15.00	15.14
9	15.71	15.86	16.01	16.15	16 29	16.44	16.58	16.74	16.88	17.03
10	17.47	17.63	17.79	17.95	18.11	18.27	18.43	18.60	18.76	18.93
11	19.21	19.39	19 56	19 74	19.92	20.09	20.27	20.46	20.63	20.82
12	20.96	21.15	21.34	21.54	21.73	21.92	22.11	22.32	22.51	22.71
13	22.71	22.91	23.12	23.33	23.54	23.75	23.95	24.18	24.38	24.60
14	24.45	24.68	24 90	25.13	25.35	25.57	25.80	26.04	26.26	26.50
15	26.20	26.44	26.68	26.92	27.16	27.40	27.64	27.90	28.14	28.39
16	27.95	28.20	28.46	28.72	28.97	29.23	29.48	29.76	30.01	30.28
17	29.69	29.97	30.24	30.51	30.78	31.05	31.33	31.62	31.89	32.18
18	31.44	31.73	32.02	32.31	32.59	32.88	33.17	33.48	33.76	34.07
19	33.19	33.49	33.80	34.10	34.40	34.71	35.01	35.34	35.64	35.96
20	34.94	35.26	35.58	35.90	36.22	36.54	36.86	37.20	37.52	37.86
21	36.68	37.02	37.35	37.69	38.03	38.36	38.70	39.06	39.39	39.75
22	38.43	38.78	39.13	39.49	39.84	40.19	40.54	40.92	41.27	41.64
23	40.18	40.54	40.91	41.28	41.65	42.02	42.38	42.78	43.14	43.53
24	41.92	42.31	42.69	43.08	43.46	43.84	44.23	44.64	45.02	45.43
25	43.67	44.07	44.47	44.87	45.27	45.67	46.07	46.50	46.90	47.32
26	45.42	45.83	46.25	46.67	47.08	47.50	47.91	48.36	48.77	49.21
27	47.16	47.60	48.03	48.46	48.89	49.32	49.76	50.22	50.65	51.11
28	48.91	49.36	49.81	50.26	50.70	51.15	51.60	52.08	52.52	53.00
29	50.66	51.12	51.59	52.05	52.51	52.98	53.44	53.94	54.40	54.89
30	52.41	52.89	53.37	53.85	54.33	54.81	55.29	55.80	56.28	56.79

23 Inches Diameter.

Inch.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	1.90	1.92	1.94	1.96	1.97	1.99	2.01	2.02	2.04	2.06
2	3.81	3 85	3.88	3.92	3.95	3.98	4 02	4.05	4.09	4.12
3	5.72	5.77	5.82	5.88	5.92	5.97	6.03	6.08	6.13	6.18
4	7.63	7.70	7.77	7.84	7.90	7.97	8.04	8.11	8.18	8.24
5	9.54	9.63	9.71	9.80	9.88	9.96	10.05	10.14	10.22	10.31
6	11.45	11.55	11.65	11.76	11.85	11.95	12.06	12.16	12.27	12.37
7	13.36	13.48	13.60	13.72	13.83	13.95	14.07	14.19	14.31	14.43
8	15.27	15.40	15.54	15.68	15.80	15.94	16.08	16.22	16.36	16.49
9	17.18	17.33	17.48	17.64	17.78	17.92	18.09	18.25	18.40	18.55
10	19 09	19.26	19.43	19.60	19.76	19.93	20.10	20.28	20.45	20.62
11	20.99	21.18	21.37	21.56	21.73	21.92	22.11	22.30	22.49	22.68
12	22.90	23.11	23.31	23.52	23.71	23.91	24.12	24.33	24.54	24.74
13	24.81	25.03	25.25	25.48	25.68	25.90	26.13	26.36	26.58	26.80
14	26.72	26.96	27.20	27.44	27.66	27.90	28.14	28.39	28.63	28.86
15	28.63	28 89	29.14	29.40	29.64	29.89	30.15	30.42	30.67	30.93
16	30.54	30.81	31.08	31.36	31.61	31.88	32.16	32.44	32 72	32.99
17	32.45	32.74	33.03	33.32	33.59	33.88	34.17	34.47	34 76	35.05
18	34.36	34.66	34.97	35.28	35.56	35.87	36.18	36.50	36.81	37.11
19	36.27	36.59	36.91	37.24	37.54	37.86	38.19	38.53	38.85	39.17
20	38.18	38.52	38.86	39.20	39.52	39.86	40.20	40.56	40.90	41.24
21	40.08	40.44	40.80	41.16	41.49	41.85	42.21	42.58	42.94	43.30
22	41.99	42.37	42.74	43.12	43.47	43.84	44.22	44.61	44 99	45.36
23	43.90	44 29	44.68	45.08	45.44	45.83	46.23	46.64	47.03	47.42
24	45 81	46.22	46.63	47.04	47.42	47.83	48.24	48.67	49 08	49.48
25	47.72	48 15	48.57	49.00	49.40	49.82	50.25	50.70	51.12	51.55
26	49.63	50.07	50.51	50.96	51.37	51.81	52.26	52.72	53.17	53.61
27	51.54	52.00	52.46	52.92	53.35	53.81	54.27	54.75	55 21	55.67
28	53.45	53.92	54.40	54.88	55.32	55.80	56.28	56.78	57.26	57.73
29	55 36	55.85	56.34	56.84	57.30	57.79	58.29	58.81	59.30	59.79
30	57.27	57.78	58.29	58.80	59.28	59 79	60.30	60.84	61.35	61.86

24 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	7	.8	.9
1	2.07	2.09	2.11	2.13	2.14	2.16	2.18	2.20	2.22	2.23
2	4 15	4.19	4.22	4.26	4.29	4.33	4.36	4.40	4.44	4.47
3	6.23	6.28	6.34	6.39	6.44	6.50	6.55	6.60	6.66	6.71
4	8.31	8.38	8.45	8.52	8.59	8.66	8.73	8.80	8.88	8.95
5	10.39	10.48	10.57	10.65	10.74	10.83	10.92	11.01	11.10	11.19
6	12.47	12.57	12.68	12.78	12.89	13.00	13.10	13.21	13.32	13.42
7	14.55	14.67	14.79	14.91	15.04	15.16	15.28	15.41	15.54	15.66
8	16.63	16.76	16.91	17.04	17.19	17.33	17.47	17.61	17.76	17.90
9	18.71	18.86	19.02	19.17	19.34	19.50	19.65	19.81	19.9	20.14
10	20.79	20.96	21.14	21.31	21.49	21.67	21.84	22.02	22.20	22.38
11	22.86	23.05	23.25	23.44	23.63	23.83	24.02	24.22	24.42	24.61
12	24.94	25.15	25.36	25.57	25 78	26.00	26.20	26.42	26.64	26.85
13	27 02	27.24	27.48	27.70	27.93	28.17	28.39	28.62	28.86	29.09
14	29.10	29.34	29.59	29.83	30.08	30.33	30.57	30.82	31.08	31.33
15	31.18	31.44	31.71	31.96	32.23	32.50	32 76	33.03	33.30	33.57
16	33.26	33.53	33.82	34.09	34.38	34.67	34.94	35.23	35.52	35.80
17	35.34	35.63	35.93	36.22	36.53	36.83	37.12	37.43	37.74	38.04
18	37.42	37.72	38.05	38.35	38.68	39.00	39.31	39.63	39 96	40.28
19	39.50	39.82	40.16	40.48	40.83	41.17	41.49	41.83	42.18	42.52
20	41.58	41.92	42.28	42.62	42.98	43.34	43.68	44.04	44.40	44.76
21	43.65	44.01	44.39	44.75	45.12	45.50	45.86	46.24	46.62	46.99
22	45.73	46.11	46.50	46.88	47.27	47.67	48.04	48.44	48.84	49.23
23	47.81	48.20	48.62	49.01	49.42	49.84	50.23	50.64	51.06	51.47
24	49 89	50.30	50.73	51.14	51.57	52.00	52.41	52.84	53.28	53.71
25	51.97	52.40	52.85	53.27	53.72	54.17	54.60	55.05	55.50	55.95
26	54 04	54.49	54.96	55.40	55.87	56.34	56.78	57.25	57.72	58.18
27	56.13	56.59	57 07	57.53	58.02	58.50	58.96	59.45	59.94	60.42
28	58.21	58.68	59.19	59.66	60.17	60.67	61.15	61.65	62.16	62.66
29	60.29	60.78	61.30	61.79	62.32	62.84	63 33	63.85	64.38	64.90
30	62.37	62.88	63.42	63.93	64.47	65.01	65.52	66.06	66.60	67.14

25 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	2.25	2.27	2.29	2.31	2.32	2.34	2.36	2.38	2.40	2.42
2	4.51	4.54	4.58	4.62	4.64	4.69	4.73	4.76	4.80	4.84
3	6.76	6.82	6.87	6.93	6.98	7.04	7.09	7.15	7.20	7.26
4	9.02	9.09	9.16	9.24	9 3	9.38	9.46	9.53	9.61	9 68
5	11.28	11.37	11.46	11.55	11.64	11.73	11.83	11.92	12.01	12.10
6	13.53	13.64	13.75	13.86	13.97	14.08	14.19	14.30	14.41	14.52
7	15.79	15.91	16.04	16.17	16.30	16.42	16.56	16.68	16.82	16.94
8	18.04	18.19	18.33	18.48	18.63	18.77	18.92	19.07	19.22	19.36
9	20.30	20.46	20.62	20.79	20.96	21.12	21.29	21.45	21.62	21.78
10	22.56	22.74	22.92	23.10	23.29	23.47	23.66	23.84	24 03	24.21
11	24.81	25.01	25.21	25.41	25.61	25.81	26.02	26.22	26.43	26.63
12	27.07	27.28	27.50	27.72	27.94	28.16	28.39	28.60	28.83	29.05
13	29.32	29.56	29.79	30.03	30.27	30.51	30.75	30.99	31.23	31.47
14	31.58	31.83	32.08	32.34	32.60	32.85	33.12	33.37	33.64	33.89
15	33.84	34.11	34.38	34.65	34.93	35.20	35.49	35.76	36.04	36.31
16	36.09	36.38	36.67	36.96	37.26	37.55	37.85	38.14	38.44	38.73
17	38.35	38.65	38.96	39.27	39.59	39.89	40.22	40.52	40.85	41.15
18	40.60	40.93	41.25	41.58	41.92	42.24	42.58	42.91	43.25	43.57
19	42.86	43.20	43.54	43.89	44.25	44.59	44.95	45.29	45.65	45.99
20	45.12	45.48	45.84	46.20	46.58	46.94	47.32	47.68	48.06	48.42
21	47.37	47.75	48.13	48.51	48.90	49.28	49.68	50.00	50.46	50.84
22	49.63	50.02	50 42	50.82	51.23	51.63	52.05	52.44	52.86	53.26
23	51.88	52.30	52.71	53.13	53.56	53.98	54.41	54.83	55.26	55.68
24	54.14	54.57	55.00	55 44	55.89	56.32	56.78	57.21	57.67	58.10
25	56.40	56.85	57.30	57.57	58.22	58.67	59.15	59.60	60.07	60.52
26	58.65	59.12	59.59	60.06	60.55	61.02	61.51	61.98	62.47	62.94
27	60.91	61.39	61.88	62.37	62.88	63.36	63.88	64.36	64.88	65.36
28	63.16	63.67	64.17	64.68	65.21	65.71	66.24	66.75	67.28	67.78
29	65.42	65.94	66.46	66 99	67.54	68.06	68.61	69.13	69.68	70.20
30	67.68	68.22	68.76	69.30	69.87	70.41	70.98	71.52	72.09	72.63

26 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	2.44	2.45	2.47	2.49	2.51	2.53	2.55	2.57	2.59	2.61
2	4.88	4.91	4.95	4.99	5.03	5.07	5.10	5.14	5.18	5.22
3	7.32	7.37	7.43	7.49	7.54	7.60	7.66	7.71	7.77	7.83
4	9 76	9.83	9 91	9.98	10.06	10.14	10.21	10.29	10.37	10.44
5	12.10	12.29	12.39	12.48	12.58	12.67	12.77	12.86	12.96	13.06
6	14.64	14.75	14.86	14.98	15.09	15.21	15.32	15.43	15.55	15.67
7	17.08	17.21	17.34	17.47	17.61	17.74	17.87	18.01	18.15	18.28
8	19.52	19.67	19.82	19.97	20.12	20.28	20.43	20.58	20.74	20.89
9	21.96	22.13	22.30	22.47	22.64	22.81	22.98	23.15	23.33	23.50
10	24.40	24.59	24.78	24.97	25.16	25.35	25.54	25.73	25.93	26.12
11	26.84	27.04	27.25	27.46	27.67	27.88	28.09	28.30	28.52	28.73
12	29.28	29.50	29.73	29.96	30.19	30.42	30.64	30.87	31.11	31.34
13	31.72	31.96	32.21	32.46	32.70	32.95	33.20	33.44	33.70	33.95
14	34.16	34.42	34.69	34.95	35.22	35.49	35.75	36.02	36 30	36.56
15	36.60	36.88	37.17	37.45	37.74	38.0.	38 31	38.59	38.89	39.18
16	39.04	39.34	39.64	39.95	40.25	40.56	40.86	41.16	41.48	41.79
17	41.48	41.80	42.12	42.44	42.77	43.09	43.41	43.74	44.08	44.40
18	43.92	44.26	44.60	44.94	45.28	45.63	45.97	46.31	46.67	47.01
19	46.36	46.72	47.08	47.44	47.80	48.16	48.52	48.88	49.26	49.62
20	48.80	49.18	49.56	49 94	50.32	50.70	51.08	51.46	51.86	52.24
21	51.24	51.63	52.03	52.43	52.83	53.23	53.63	54.03	54.45	54.85
22	53.68	54.09	54.51	54.93	55.35	55.77	56.18	56.60	57.04	57.46
23	56.12	56.55	56.99	57.43	57.86	58.30	58.74	59.17	59.63	60.07
24	58.56	59.01	59.47	59.92	60.38	60.84	61.29	61.75	62.23	62.68
25	61.00	61.47	61.95	62 42	62.90	63.37	63.85	64.32	64.82	65.30
26	63.44	63 93	64.42	64.92	65.41	65.91	66.40	66.89	67.41	67.91
27	65.88	66.39	66.90	67.41	67.93	68.44	68.95	69.47	70.01	70.52
28	68.32	68.85	69.38	69.91	70.44	70.98	71.51	72.04	72.60	73.13
29	70.76	71.31	71.86	72.41	72.96	73.51	74.06	74.61	75.19	75.74
30	73.20	73.77	74.34	74 91	75.48	76.05	76.62	77.19	77.79	78.36

27 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	2.63	2.65	2.67	2.69	2.71	2.73	2.75	2.77	2.79	2.81
2	5.26	5.30	5.34	5.38	5.42	5.46	5.50	5.54	5 58	5 62
3	7.89	7.95	8.01	8.07	8.13	8.19	8.25	8.31	8.37	8.43
4	10.52	10.60	10.68	10.76	10.84	10.92	11.00	11.08	11.16	11.24
5	13.15	13.25	13.35	13 45	13 55	13.65	13.75	13.85	13.95	14.05
6	15.78	15.90	16.02	16.14	16.26	16.38	16.50	16.62	16.74	16.86
7	18.41	18.55	18.69	18.83	18.97	19.11	19.25	19.39	19.53	19.67
8	21.04	21.20	21.36	21.52	21 68	21 84	22.00	22.16	22.32	22.48
9	23.67	23.85	24.03	24.21	24.39	24.57	24.75	24.93	25.11	25.29
10	26.31	26.51	26.71	26.90	27.10	27.30	27.50	27.70	27.90	28 10
11	28.94	29.16	29.38	29.59	29.81	30.03	30.25	30 47	30.69	30.91
12	31.57	31.81	32.05	32.28	32.52	32.76	33.00	33.24	33.48	33.72
13	34.20	34.46	34.72	34.97	35.23	35.49	35.75	36.01	36.27	36.53
14	36.83	37.11	37.39	37.66	37.94	38.22	38.50	38.78	39.06	39.34
15	39.46	39.76	40.06	40.35	40.65	40.95	41.25	41.55	41.85	42.15
16	42.09	42.41	42.73	43.04	43 36	43.68	44.00	44 32	44.64	44.96
17	44.72	45.06	45.40	45.73	46.07	46.41	46.75	47.09	47.43	47.77
18	47.35	47.71	48.07	48.42	48.78	49.14	49.50	49.86	50.22	50.58
19	49.98	50.36	50.74	51.11	51.49	51.87	52.25	52.63	53.01	53.39
20	52.62	53.02	53.42	53.80	54.20	54.60	55.00	55.40	55.80	56.20
21	55.25	55.67	56.09	56.49	56.91	57.33	57.75	58.17	58.59	59.01
22	57 88	58.32	58 76	59.18	59.62	60.06	60.50	60.94	61.38	61.82
23	60.51	60.97	61.43	61.87	62.33	62.79	63.25	63.71	64.17	64.63
24	63.14	63.62	64.10	64.56	65.04	65.52	66.00	66.48	66.96	67.44
25	65 76	66.27	66.77	67.25	67.75	68.25	68 75	69.25	69.75	70.25
26	68.40	68.92	69.44	69 94	70.46	70.98	71.50	72.02	72.54	73.06
27	71.03	71.57	72.11	72.63	73.17	73.71	74.25	74.79	75.33	75.87
28	73.66	74.22	74.78	75.32	75.88	76.44	77.00	77.56	78.12	78.68
29	76.29	76.87	77.45	78.01	78.59	79.17	79.75	80.33	80.91	81.49
30	78.93	79.52	80.13	80.70	81.30	81.90	82.50	83.10	83.70	84.30

28 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	2.83	2.85	2.87	2.89	2 91	2 93	2.95	2.97	2.99	3.01
2	5.66	5.70	5.74	5.78	5 82	5.86	5.90	5.94	5.98	6.03
3	8.49	8.55	8.61	8 67	8.73	8.79	8.85	8.91	8,98	9.04
4	11.32	11.40	11.48	11.56	11.64	11.72	11.81	11 89	11.97	12.06
5	14.15	14.25	14.35	14.45	14.55	14.66	14.76	14.86	14.97	15.07
6	16.98	17.10	17.22	17.34	17.46	17.59	17.71	17.83	17.96	18.09
7	19 71	19.95	20.09	20.23	20.37	20.52	20.67	20.81	20.95	21.10
8	22,64	22.80	22.96	23.12	23 28	23.45	23 62	23.78	23.95	24.12
9	25.47	25.65	25.83	26.01	26.19	26.38	26.57	26.75	26.94	27.13
10	28.30	28.50	28.71	28.91	29.11	29.32	29.53	29.73	29.94	30.15
11	31.13	31.35	31.58	31.80	32.02	32.25	32.48	32.70	32.93	33.16
12	33.96	34.20	34.45	34.69	34 93	35.18	35.45	35.67	35.92	36.18
13	36.79	37.05	37.32	37.58	37.84	38.11	38.38	38.64	38.92	39.19
14	39.62	39.90	40.19	40 47	40.75	41.04	41.34	41.62	41.91	42.21
15	42.45	42.75	43.06	43.36	43.66	43.98	44.29	44.59	44.91	45.22
16	45.28	45.60	45 93	46.25	46 57	46 91	47.24	47.56	47.90	48.24
17	48.11	48.45	48.80	49.14	49.48	49.84	50.20	50.54	50.89	51.25
18	50.94	51.30	51.67	52.03	52.39	52.77	53.15	53.51	53.89	54.27
19	53.77	54.15	54.54	54.92	55.30	55 70	56.10	56.48	56.88	57.28
20	56.60	57.00	57.42	57.82	58.22	58.64	59.06	59.46	59.88	60.30
21	59.43	59.85	60.29	60.71	61.13	61.57	62.01	62.43	62.87	63.31
22	62.26	62.70	63.16	63.60	64.04	64.50	64.96	65.40	65.86	66.33
23	65.09	65.55	66.03	66.49	66.95	67.43	67.91	68-37	68.86	69.34
24	67.92	68.40	68.90	69.38	69.86	70.36	70.87	71.35	71.85	72.36
25	70 75	71.25	71.77	72.27	72.77	73.30	73 82	74.32	74 85	75.37
26	73.58	74.10	74.64	75.16	75.68	76.23	76.77	77.29	77.84	78.39
27	76.41	76 95	77.51	78.05	78.59	79.16	79.73	80.27	80.83	81 40
28	79.24	79.80	80.38	80.94	81.50	82.09	82.68	83.24	83.83	84.42
29	82.07	82.65	83.25	83.83	84.41	85.02	85.63	86.21	86.82	87.43
30	84.90	85.50	86.13	86.73	87.33	87.96	88 59	89.19	89.82	90.45

29 Inches Diameter.

Depth	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	3.03	3.05	3.07	3.09	3.12	3.14	3.16	3.18	3.20	3.22
2	6.07	6.11	6.15	6.19	6.24	6.28	6.32	6.36	6.41	6.45
3	9.10	9.17	9.23	9.29	9.36	9.42	9.48	9.55	9.61	9.68
4	12.14	12.22	12.31	12.39	12.48	12.56	12.65	12.73	12.82	12.90
5	15.18	15.28	15.39	15.49	15.60	15.70	15.81	15.92	16.02	16.13
6	18.21	18.34	18.46	18.59	18.72	18.84	18.97	19.10	19.23	19.36
7	21.25	21.39	21.54	21.69	21.84	21.98	22.14	22.28	22.43	22.58
8	24.28	24.45	24.62	24.79	24.96	25.12	25.30	25.47	25.64	25.81
9	27.32	27.51	27.70	27.89	28.08	28.26	28.46	28.65	28.84	29.04
10	30.36	30.57	30.78	30.99	31.20	31.41	31.63	31.84	32.05	32.27
11	33.39	33.62	33.85	34.08	34.32	34.55	34.79	35.02	35.25	35.49
12	36.43	36.68	36.93	37.18	37.44	37.69	37.95	38.20	38.46	38.72
13	39.46	39.74	40.01	40.28	40.56	40.83	41.11	41.39	41.66	41.95
14	42.50	42.79	43.09	43.38	43.68	43.97	44.28	44.57	44.87	45.17
15	45.54	45.85	46.17	46.48	46.80	47.11	47.44	47.76	48.07	48.40
16	48.57	48.91	49.24	49.58	49.92	50.25	50.60	50.94	51.28	51.63
17	51.61	51.96	52.32	52.68	53.04	53.39	53.77	54.12	54.48	54.85
18	54.64	55.02	55.40	55.78	56.16	56.53	56.93	57.31	57.69	58.08
19	57.68	58.08	58.48	58.88	59.28	59.67	60.09	60.49	60.89	61.31
20	60.72	61.14	61.56	61.98	62.40	62.82	63.26	63.68	64.10	64.54
21	63.75	64.19	64.63	65.07	65.52	65.96	66.42	66 86	67.30	67.76
22	66.79	67.25	67.71	68.17	68.64	69.10	69 58	70.04	70.51	70.99
23	69.82	70.31	70.79	71.27	71.76	72.24	72.74	73.23	73.71	74.22
24	72.86	73.36	73.87	74.37	74.88	75.38	75.91	76.41	76.92	77.44
25	75.90	76.42	76.95	77.47	78.00	78.52	79.07	79.60	80.12	80.67
26	78.93	79.48	80.02	80.57	81.12	81.66	82.23	82.78	83.33	83.90
27	81.97	82.53	83.10	83.67	84.24	84.80	85.40	85.96	86.53	87.12
28	85.00	85.59	86.18	86.77	87.36	87.94	88.56	89.15	89.74	90.35
29	88.04	88.65	89.26	89.87	90.48	91.08	91.72	92.33	92.94	93.58
30	91.08	91.71	92.34	92.97	93.60	94.23	94.89	95.52	96.15	96.81

30 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	3.24	3.27	3.29	3.31	3.33	3.35	3.38	3.40	3.42	3.44
2	6.49	6.54	6.58	6.62	6.67	6.71	6.76	6.80	6.84	6.89
3	9.74	9.81	9.87	9.94	10.00	10.07	10.14	10.20	10.27	10.34
4	12.99	13.08	13.16	13.25	13.34	13.43	13.52	13.60	13.69	13.78
5	16.24	16.35	16.46	16.57	16.68	16.79	16.90	17.01	17.12	17.23
6	19.49	19.62	19.75	19 88	20.01	20.14	20.28	20.41	20.54	20.68
7	22.74	22.89	23.04	23.19	23.35	23.50	23.66	23.81	23.96	24.12
8	25.99	26.16	26.33	26.51	26.68	26.86	27.04	27.21	27.39	27.57
9	29.24	29.43	29.62	29.82	30.02	30.22	30.42	30.61	30.81	31.02
10	32.49	32.70	32.92	33.14	33.36	33.58	33.80	34.02	34.24	34.47
11	35.73	35.97	36.21	36.45	36.69	36.93	37.18	37.42	37.66	37.91
12	38.98	39.24	39.50	39.76	40.03	40.29	40.56	40.82	41.08	41.36
13	42.23	42.51	42.70	43.08	43.36	43.65	43.94	44.22	44.51	44.81
14	45.48	45.78	46.08	46.39	46.70	47.01	47.32	47.62	47.93	48.25
15	48.73	49.05	49.38	49.71	50.04	50.37	50.70	51.03	51.36	51.70
16	51.98	52.32	52.67	53.02	53.37	53.72	54.08	54.43	54.78	55.15
17	55.23	55.59	55.96	56.33	56.71	57.08	57.46	57.83	58.20	58.59
18	58.48	58.86	59.25	59.65	60.04	60.44	60.84	61.21	61.63	62.04
19	61.73	62.13	62.54	62.96	63.38	63.80	64.22	64.63	65.05	65.49
20	64.98	65.40	65.84	66.28	66.72	67.16	67.60	68.04	68.48	68.94
21	68.22	68.67	69.13	69.59	70.05	70 51	70.98	71.44	71.90	72.38
22	71.47	71.94	72.42	72.90	73.39	73.87	74.36	74.84	75.32	75.83
23	74.72	75.21	75.71	76.22	76.72	77.2	77.74	78.24	78.75	79.28
24	77.97	78.48	79.00	79.53	80.06	80.59	81.12	81.64	82.17	82.72
25	81.22	81.75	82.30	82.85	83.40	83.95	84.50	85.05	85.60	86.17
26	84.47	85.02	85.59	86.16	86.73	87.30	87.88	88.45	89.02	89.62
27	87.72	88.29	88.88	89.47	90.07	90.66	91.26	91.85	92.44	93.06
28	90.97	91.56	92.17	92.79	93.40	94.02	94.64	95.25	95.87	96.51
29	94.22	94.83	95.46	96.10	96.74	97.38	98.02	98.65	99.29	99.96
30	97.47	98.10	98.76	99.42	100.08	100.74	101.40	102.06	102.72	103.41

31 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	
1	3.46	3.49	3.51	3.53	3.55	3.58	3.60	3.62	3.65	
2	6.93	6.98	7.02	7.07	7.11	7.16	7.20	7.25	7.30	
3	10.40	10.47	10.54	10.60	10.67	10.74	10.81	10.88	10.95	
4	13.87	13.96	14.05	14.14	14.23	14.32	14.41	14.50	14.60	
5	17.34	17.45	17.57	17.68	17.79	17.91	18.02	18.13	18.25	
6	20.81	20.94	21.08	21.21	21.35	21.49	21.62	21.76	21.90	
7	24.28	24.43	24.59	24.75	24.91	25.07	25.22	25.38	25.55	
8	27.75	27.92	28.11	28.28	28.47	28.65	28.83	29.01	29.20	
9	31.22	31.41	31.62	31.82	32.03	32.23	32.43	32.64	32.85	
10	34.69	34.91	35.14	35.36	35.59	35 82	36.04	36.27	36.50	
11	38.15	38.40	38.65	38.89	39.14	39.40	39.64	39.89	40.15	
12	41.62	41.89	42.16	42.43	42.70	42.98	43.24	43.52	43.80	
13	45.09	45.38	45.68	45.96	46.26	46.56	46.85	47.15	47.45	
14	48.56	48.87	49.19	49.50	49.82	50.14	50.45	50.77	51.10	
15	52.03	52 36	52.71	53.04	53 38	53.73	54.06	54.40	54.75	
16	55.50	55.85	56.22	56.57	56.94	57.31	57.66	58.03	58.40	
17	58.97	59.34	59.73	60.11	60.50	60.89	61.26	61.65	62.05	
18	62.44	62.83	63.25	63.64	64.06	64 47	64.87	65.28	65.70	
19	65.91	66.32	66.76	67.18	67.62	68.05	68.47	68.91	69 35	
20	69.38	69.82	70.28	70.72	71.18	71.64	72 08	72.54	73.00	
21	72.84	73.31	73.79	74 25	74.73	75.22	75.68	76.16	76.65	
22	76.31	76.80	77.30	77.79	78.29	78.80	79.28	79.97	80.30	
23	79.78	80.29	80.82	81.32	81.85	82.38	82.89	83.42	83.95	
24	83.25	83.78	84.33	84.86	85.41	85.96	86.49	87.04	87.60	
25	86.72	87.27	87.85	88.40	88.97	89.55	90.10	90.67	91.25	
26	90.19	90.76	91.36	91.93	92.53	93.13	93.70	94.30	94 90	
27	93.66	94.25	94.87	95.47	96.09	96.71	97.30	97.92	98.55	
28	97.13	97.74	98.39	99.00	99.65	100.29	100 91	101.55	102.20	1
29	100.60	101.23	101.90	102.54	103.21	103.87	104.51	105.18	105.85	1
30	104.07	104.73	105.42	106.08	106.77	107.46	108.12	108.81	109.50	1

32 Inches Diameter.

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	3.69	3.72	3.74	3.76	3.78	3.81	3 83	3.86	3.88	3.90
2	7.39	7.44	7.48	7 53	7.57	7.62	7.67	7.72	7 76	7.81
3	11.08	11.16	11.22	11.29	11.36	11.43	11.50	11.58	11.65	11.72
4	14.78	14.88	14.97	15.06	15.15	15.25	15.34	15 44	15.53	15.62
5	18.48	18.60	18.71	18.83	18.94	19.06	19.18	19.30	19.42	19.53
6	22.17	22.32	22.45	22.59	22.73	22.87	23.01	23.16	23.30	23.44
7	25.87	26.04	26.20	26.36	26.52	26.69	26.85	27.02	27.18	27.34
8	29.56	29.76	29.94	30.12	30.31	30.50	30.68	30.88	31.07	31.25
9	33.26	33.48	33.68	33.89	34.10	34.31	34.52	34.74	34.95	35.16
10	36.96	37.20	37.43	37.66	37.89	38.13	38.36	38.60	38.84	39.07
11	40.65	40.92	41.17	41.42	41.67	41.94	42.19	42.46	42.72	42.97
12	44.35	44.64	44.91	45.19	45.46	45 75	46.03	46.32	46.60	46.88
13	48.04	48.36	48.65	48.95	49.25	49.56	49.86	50.18	50.49	50.79
14	51.74	52.08	52.40	52.72	53.04	53.38	53.70	54.04	54.37	54.69
15	55.44	55.80	56.14	56.49	56.83	57.19	57.54	57.90	58.26	58.60
16	59.13	59.52	59.88	60.25	60.62	61.00	61.37	61 76	62.14	62.51
17	62.83	63.24	63.63	64.02	64.41	64.82	65.21	65.62	66.02	66.41
18	66.52	66.96	67.37	67.78	68.20	68.63	69.04	69.48	69.91	70.32
19	70.22	70.68	71.11	71.55	71.99	72.44	72.88	73.34	73.79	74.23
20	73.92	74.40	74.86	75.32	75.78	76.26	76.72	77.20	77.68	78.14
21	77.61	78.12	78.60	79.08	79 56	80.07	80.55	81.06	81.56	82.04
22	81.31	81.84	82.34	82.85	83.35	83.88	84.39	84.92	85 44	85.95
23	85.00	85.56	86.08	86.61	87.14	87.69	88.22	88.78	89.33	89.86
24	88.70	89.28	89.83	90.38	90 93	91.51	92.06	92.64	93.21	93.76
25	92.40	93.00	93.57	94.15	94.72	95.32	95.90	96.50	97.10	97.67
26	96.09	96.72	97.31	97.91	98.51	99.13	99.73	100.36	100.98	101.58
27	99.79	100.44	101.06	101.68	102.30	102.95	103.57	104.22	104.86	105.48
28	103.48	104.16	104.80	105.44	106.09	106.76	107.40	108.08	108.75	109.39
29	107.18	107.88	108.54	109.21	109 88	110.57	111.24	111.94	112.63	113.30
30	110.88	111.60	112.20	112 98	113 67	114.39	115.08	115.80	116.52	117.21

33 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	3.93	3.95	3.97	4.00	4.02	4.05	4.07	4.10	4.12	4.1
2	7.86	7.91	7.95	8.00	8.05	8.10	8.15	8.20	8.24	8.2
3	11.79	11.86	11.93	12.00	12.08	12.15	12.22	12.30	12.37	12.4
4	15.72	15.82	15.91	16.01	16.10	16.20	16.30	16.40	16.49	16.5
5	19.65	19.77	19.89	20.01	20.13	20.25	20.37	20.50	20.62	20.7
6	23 58	23.73	23.87	24.01	24.16	24.30	24.45	24.60	24.74	24.8
7	27.51	27.68	27.85	28.02	28.18	28.35	28.52	28.70	28.86	29.0
8	31.44	31.64	31.83	32.02	32.21	32.40	32.60	32.80	32.99	33.1
9	35.37	35.59	35.81	36.02	36.24	36.45	36.67	36.90	37.11	37.3
10	39 3	39.53	29.79	40.03	40.27	40.51	40.75	41.00	41.24	41.4
11	43.24	43 50	43 76	44.03	44.29	44.56	44.82	45 10	45.36	45.6
12	47 17	47.46	47.74	48.03	48 31	48.61	48.90	49.20	49.48	49.7
13	51.10	51.41	51.72	52 03	52.35	52.66	52.97	53.30	53.61	53.9
14	55.03	55.37	55.71	56.04	56.37	56.71	57.05	57.50	57.73	58.0
15	58.96	59.32	59.69	60.04	60.40	60.76	61.12	61.50	61.86	62.2
16	62.89	63.28	63.67	64.04	64.43	64.81	65.20	65.60	65.98	66.3
17	66.82	67.23	67.65	68.05	68.45	68.86	69.27	69.70	70.10	70.5
18	70.75	71.19	71.63	72.05	72.48	72.91	73.35	73.80	74.23	74.6
19	74.68	75.14	75.61	76.05	76.51	76.96	77.42	77.90	78.35	78.8
20	78.62	79.10	79.59	80.06	80.54	81.02	81.50	82.00	82.48	82.9
21	82.55	83-05	83.56	84.06	84.56	85.07	85.57	86.10	86.60	87.1
22	86.48	87.01	87.54	88.06	88.59	89.12	89.65	90.20	90.72	91.2
23	90.41	90.96	91.52	92.06	92.62	93.17	93.72	94.30	94.85	95.4
24	94.34	94.92	95.50	96.07	96.64	97.22	97.80	91.40	98.97	99.5
25	98.27	98.87	99.48	100.07	100.67	101.27	101.87	102.50	103.10	103.7
26	102.20	102.83	103.46	104.07	104.70	105.32	105.95	106.60	107.22	107.8
27	106.13	106 78	107.44	108.08	108.72	109.37	110.02	110.70	111.34	111.9
28	110.06	110.74	111.42	112.08	112.75	113.42	114.10	114.80	115.47	116.1
29	113 99	114.69	115.40	116.08	116.78	117.47	118.17	118.90	119.59	120.2
30	117.93	118.65	119.37	120.09	120.81	121.53	122.25	123.00	123 72	124.4

34 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	4 17	4.19	4.22	4.24	4.27	4.29	4.32	4.34	4.37	4.39
2	8.34	8.39	8.44	8.49	8.54	8.59	8.64	8.69	8.74	8.79
3	12.51	12.59	12.66	12.74	12.81	12.88	12.96	13.03	13.11	13.19
4	16.69	16.78	16.88	16.98	17.08	17.18	17.28	17.38	17.48	17.58
5	20.86	20.98	21.11	21.23	21.35	21.48	21.60	21.73	21.86	21.98
6	25.03	25.18	25.33	25.48	25.62	25.77	25.92	26.07	26.23	26.38
7	29.21	29.37	29.55	29.72	29.89	30.07	30.24	30.42	30.60	30.77
8	33.38	33.57	33.77	33.97	34.16	34.36	34 56	34.76	34.97	35.17
9	37.55	37.77	37.99	38.22	38.43	38.66	38.88	39.11	39.34	39.57
10	41.73	41.97	42.22	42.47	42.71	42.96	43.21	43.46	43.72	43.97
11	45.90	46.16	46.44	46.71	46.98	47.25	47.53	47.80	48.09	48.36
12	50.07	50.36	50.66	50.96	51.25	51.55	51.85	52.15	52.46	52.76
13	54.24	54.56	54.88	55.21	55.52	55.84	56.17	56.49	56.83	57.16
14	58.42	58.75	59.10	59.45	59.79	60.14	60.49	60.84	61.20	61.55
15	62.59	62.95	63.33	63.70	64.06	64.44	64.81	65.19	65.58	65.95
16	66.76	67.15	67.55	67 95	68 33	68.73	69.13	69.53	69.95	70.35
17	70.94	71.34	71.77	72.19	72.60	73 03	73.45	73.88	74.32	74.74
18	75.11	75.54	75.99	76.44	76.87	77.32	77.77	78.22	78.69	79.14
19	79.28	79.74	80.21	80.69	81.14	81.62	82.09	82.57	83.06	83.54
20	83.46	83.94	84.44	84.94	85.42	85.92	86.42	86.92	87.44	87.94
21	87.63	88.13	88.66	89.18	89.69	90.21	90.74	91.26	91.81	92.33
22	91.80	92.33	92.88	93.43	93.96	94.51	95.06	95.61	96.18	96.73
23	95.97	96.53	97.10	97.68	98.23	98.80	99.38	99.95	100.55	101,13
24	100.15	100.72	101.32	101.92	102.50	103.10	103.70	104.30	104.92	105.51
25	104.32	104.92	105.55	106.17	106.77	107.40	108.02	108.65	109.30	109.92
26	108.49	109.12	109 77	110.42	111.04	111.69	112.34	112 99	113.67	114.32
27	112 67	113.31	113.99	114.66	115.31	115.99	116.66	117.34	118.04	118 71
28	116.84	117.51	118.21	118.91	119 58	120.28	120.98	121.68	122.41	123.11
29	121.01	121.71	122.43	123.16	123.85	124.58	125.30	126.02	126.78	127.51
30	125.19	125.91	126.66	127 41	128.13	128.88	129.63	130.38	131.16	131.91

35 Inches Diameter.

Depth	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	4.42	4.44	4.47	4.49	4.52	4.54	4 57	4.60	4.62	4
2	8.84	8.89	8.94	8.99	9.04	9.09	9.15	9.20	9.25	9
3	13.26	13.34	13.41	13.49	13.57	13.64	13.72	13.80	13.87	13
4	17.68	17.78	17.89	17.99	18.09	18.19	18.30	18.40	18.50	18
5	22.11	22.23	22.36	22.49	22.62	22.74	22.87	23.00	23.13	23
6	26.53	26.68	26.83	26.98	27.14	27.29	27.45	27.60	27.75	27
7	30.95	31.12	31.31	31.48	31.66	31.84	32.02	32.20	32.38	32
8	35.37	35.57	35.78	35.98	36.19	36.39	36.60	36.80	37.00	37
9	39.79	40.02	40.25	40.48	40.71	40.94	41.17	41.40	41.63	41
10	44.22	44.47	44.73	44.98	45.24	45.49	45.75	46.01	46.26	46
11	48.64	48.91	49.20	49 47	49.76	50.03	50.32	50.61	50.88	51
12	53.06	53.36	53.67	53.97	54.28	54.58	54.90	55.21	55.51	55
13	57.48	57.81	58.14	58.47	58.81	59.13	59.47	59.81	60.13	60
14	61.90	62.25	62.62	62.97	63.33	63.68	64.05	64.41	64.76	65
15	66.33	66.70	67.09	67.47	67.86	68.23	68.62	69.01	69.39	69
16	70.75	71.15	71.56	71.96	72.38	72.78	73.20	73.61	74.01	74
17	75.17	75.59	76.04	76.46	76.90	77.33	77.77	78.21	78.64	79
18	79.59	80.04	80.51	80.96	81.43	81.88	82.35	82.81	83.26	83
19	84.01	84.49	84.98	85.46	85.95	86.43	86.92	87.41	87.89	88
20	88.44	88.94	89.46	89.96	90.48	90.98	91.50	92.02	92.52	93
21	92.86	93.38	93.93	94.45	95.00	95.52	96.07	96.62	97.14	97
22	97.28	97.83	98.40	98.95	99.52	100.07	100.65	101.22	101.77	102
23	101.70	102.28	102.87	103.45	104.05	104.62	105.22	105.82	106 39	106
24	106.12	106.72	107.35	107.95	108.57	109.17	109.80	110.42	111.02	111
25	110.55	111.17	111.82	112 45	113.10	113.72	114.37	115.02	115.65	116
26	114.97	115.62	116.29	116.94	117.62	118.27	118.95	119.62	120.27	120
27	119.39	120.06	120.77	121.44	122.14	122.82	123.52	124.22	124.90	125
28	123.81	124.51	125.24	125.94	126.67	127.37	128.10	128.82	129.52	130
29	128.23	128.96	129.71	130.44	131.19	131.92	132.67	133.42	134.15	134
30	132.66	133.41	134.19	134.84	135.72	136.47	137.25	138.03	138.78	139

36 Inches Diameter.

Depth	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	4.07	4.70	4.73	4.75	4.78	4.80	4.83	4.86	4.88	4.91
2	9.35	9.40	9.46	9.51	9.56	9.61	9.67	9.72	9.77	9.83
3	14.03	14.11	14.19	14.26	14.34	14.42	14.50	14.58	14.66	14.74
4	18.71	18.81	18.92	19 02	19.13	19.23	19.34	19.44	19.55	19.66
5	23.39	23.52	23.65	23.78	23.91	24.04	24.18	24 31	24.44	24.57
6	28.06	28.22	28.38	28.53	28.69	28.85	29.01	29.17	29.32	29.49
7	32.74	32.92	33.11	33.29	33.48	33.66	33.85	34.03	34.21	34.40
8	37.42	37.63	37 84	38.04	38.26	38.47	38.68	38.89	39.10	39.32
9	42.10	42.33	42.57	42.80	43.04	43.28	43.52	43.75	43.99	44.23
10	46.78	47.04	47.30	47.56	47.83	48.09	48.36	48.62	48.88	49.15
11	51.45	51 74	52.03	52.31	52.61	52.89	53.19	53.48	53.76	54.06
12	56.13	56.44	56.76	57.07	57.39	57.70	58.03	58.34	58.65	58.98
13	60.81	61.15	61.49	61.82	62.17	62.51	62.86	63.20	63.54	63.89
14	65.49	65.85	66.22	66.58	66.96	67.32	67.70	68.06	68.43	68.81
15	70.17	70.56	70.95	71.34	71.74	72.13	72.54	72.93	73.32	73.72
16	74.84	75.26	75.68	76.09	76.52	76.94	77.37	77.79	78.20	78.64
17	79.52	79.96	80.41	80.85	81.31	81.75	82.21	82.65	83.09	83.55
18	84.20	84.67	85.14	85.60	86.09	86.56	87 04	87.51	87.98	88 47
19	88.88	89.37	89.87	90.36	90.87	91.37	91.88	92.37	92.87	93.38
20	93.56	94.08	94.60	95.12	95.66	96.18	96.72	97.24	97.76	98.30
21	98.23	98.78	99.33	99 87	100.44	100.98	101.55	102.10	102.64	103.21
22	102.91	103.48	104.06	104.63	105.22	105.79	106.39	106.96	107.53	108 13
23	107.59	108.19	108.79	109 38	110.00	110.60	111.22	111.82	112.42	113.04
24	112.27	112.89	113.52	114.14	114.79	115.41	116.06	116.68	117 31	117.96
25	116.95	117.60	118.25	118.90	119.57	120.22	120.90	121.55	122.20	122.87
26	121.62	122 30	122.98	123.65	124.35	125.03	125.73	126.41	127.08	127.79
27	126.30	127.00	127.71	128.41	129.14	129.84	130.57	131.27	131.97	132.70
28	130.98	131.71	132.44	133.16	133.92	134.65	135.40	136.13	136 86	137.62
29	135.66	136.41	137.17	137.92	138.70	139.46	140.24	140.99	141 75	142.53
30	140.34	141.12	141.90	142.68	143 49	144.27	145.08	145.86	146.64	147.45

37 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	4.94	4.96	4.99	5.02	5.04	5.07	5.10	5.13	5.15	5.18
2	9.88	9.93	9.99	10.04	10.09	10.15	10.20	10.26	10.31	10.37
3	14.82	14.90	14.98	15.06	15.14	15.22	15.30	15.39	15.47	15.55
4	19.76	19.87	19.98	20.08	20.19	20.30	20.41	20.52	20.63	20.74
5	24.71	24.84	24.97	25.11	25.24	25.38	25.51	25.65	25.79	25.92
6	29.65	29.80	29.97	30.13	30.29	30 45	30.61	30 78	30.94	31.11
7	34.59	34.77	34.96	35.15	35.34	35.53	35 72	35.91	36.10	36.29
8	39.53	39.74	39 96	40.17	40.39	40.60	40.82	41.04	41.26	41.48
9	44.47	44 71	44.95	45.19	45.44	45.68	45.92	46.17	46.42	46.68
10	49.42	49 68	49.95	50.22	50.49	50.76	51.03	51.31	51.58	51.87
11	54.36	54 64	54.94	55.24	55.53	55.83	56.13	56.44	56.73	57.03
12	59.30	59.61	59.94	60.26	60.58	60.91	61.23	61.57	61.89	62.22
13	64.24	64.58	64.93	65.28	65.63	65.98	66.33	66.70	67.05	67.41
14	69.18	69.55	69.93	70.30	70.68	71.06	71 44	71.83	72.21	72.59
15	74.13	74.52	74.92	75.33	75.73	76.14	76.54	76.96	77.37	77.78
16	79.07	79.48	79.92	80.35	80.78	81.21	81.64	82.09	82.52	82.96
17	84.01	84.45	84.91	85.37	85.83	86.29	86.75	87.22	87.68	88.15
18	88.95	89.42	89.91	90.39	90.88	91.36	91.85	92.35	92.84	93.33
19	93.89	94.39	94.90	95.41	95.93	96.44	96.95	97.48	98.00	98.52
20	98.84	99.36	99.90	100.44	100 98	101.52	102.06	102.62	103.16	103.71
21	103.78	104.32	104.89	105.46	106.02	106.59	107.16	107.75	108.31	108.88
22	108.72	109.29	109.89	110.48	111.07	111.67	112.26	112.88	113.47	114.07
23	113.66	114.26	114 88	115.50	116.12	116.74	117 36	118.01	118.63	119.25
24	118.60	119.23	119.88	120.52	121.17	121.82	122.47	123.14	123.79	124.44
25	123.55	124 20	124.87	125.55	126.22	126.90	127.57	128.27	128.95	129.62
26	128.49	129.16	129 87	130.57	131.27	131.97	132.67	133.40	134.10	134.80
27	133.43	134.13	134.86	135.59	136.32	137.05	137.78	138.53	139.26	139.99
28	138.37	139.10	139.86	140.61	141.37	142.12	142.88	143.66	144.42	145.18
29	143.31	144.07	144 85	145.63	146.42	147.20	147.98	148.79	149.58	150.37
30	148.26	149.04	149.85	150.66	151.47	152.28	153.00	153.93	154.74	155.55

38 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	5.21	5.24	5.26	5.29	5.32	5.35	5.37	5.40	5.43	5.46
2	10.42	10.48	10.53	10.59	10.64	10.70	10.75	10.81	10.86	10.92
3	15.63	15.72	15.80	15.88	15.96	16.05	16.13	16.21	16.30	16.38
4	20.84	20.96	21.06	21.18	21.29	21.40	21.51	21.62	21.73	21.84
5	26.06	26.20	26.33	26.47	26.61	26.75	26.89	27.03	27.17	27.31
6	31.27	31.44	31.60	31.77	31.93	32.10	32.26	32.43	32.60	42.77
7	36.48	36.68	36.86	37.06	37.26	37.45	37.64	37.84	38.03	38.23
8	41.69	41.92	42.13	42.36	42.58	42.80	43.02	43.24	43.47	40.69
9	46.90	47.16	47.40	47.65	47.90	48.15	48.40	48.65	48.90	49.15
10	52.12	52.40	52.67	52.95	53.23	53.51	53.78	54.06	54.34	54.62
11	57.33	57.64	57.93	58 24	58.55	58.86	59.15	59.46	59.77	60.08
12	62.54	62.88	63.20	63.54	63.87	64.21	64.53	64.87	65.20	65.54
13	67.75	68.12	68.47	68.83	69.19	69.56	69 91	70.27	70.64	71.00
14	72.96	73.36	73.73	74.13	74.52	74.91	75.29	75.68	76.07	76.46
15	78.18	78.60	79.00	79 42	79.84	80.26	80.67	81.09	81.51	81.93
16	83.39	83.84	84.27	84.72	85.16	85 61	86.04	86.49	86.94	87.39
17	88.60	89.08	89.53	90.01	90.49	90.96	91.42	91.90	92.37	92.85
18	93.81	94.32	94 80	95.31	95.81	96.31	96.80	97.30	97.81	98.31
19	99.02	99.56	100.07	100.60	101.13	101.66	102.18	102.71	103.24	103.77
20	104.24	104.80	105.34	105.90	106.46	107.02	107.56	108.12	108.68	109.24
21	109.45	110.04	110.60	111.19	111.78	112.37	112.93	113.52	114.11	114.70
22	114.66	115.28	115.87	116.49	117.10	117 72	118.31	118.93	119.54	120.16
23	119.87	120.52	121.14	121.78	122.42	123.07	123.69	124.33	124.98	125.62
24	125.08	125.76	126.40	127.08	127.75	128.42	129.07	129.74	130.41	131.08
25	130.30	131.00	131.67	132.37	133.07	133.77	134.45	135.15	135.85	136.55
26	135.51	136.24	136.94	137.67	138.39	139.12	139.82	140.55	141.28	142.01
27	140.72	141.48	142.20	142.96	143.72	144.47	145.20	145.96	146.71	147.47
28	145.93	146.72	147.47	148.26	149.04	149.82	150 58	151.36	152.15	152.93
29	151.14	151.96	152.74	153.55	154.36	155.17	155.96	156.77	157.58	158.39
30	156.36	157.20	158.01	158.85	159.69	160.53	161.34	162.18	163.02	163.86

39 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	5.49	5.51	5.54	5.57	5.60	5.63	5.66	5.68	5.71	5.74
2	10.98	11.03	11.09	11.15	11.20	11.26	11.32	11.37	11.43	11.49
3	16.47	16.55	16.64	16.72	16.81	16.89	16.98	17.06	17.15	17.24
4	21.96	22.07	22.18	22.30	22.41	22.52	22.64	22.75	22.87	22.98
5	27.45	27.59	27.73	27.87	28.02	28.16	28.30	28.44	28.59	28.73
6	32.94	33.11	33 28	33.45	33.62	33.79	33.96	34.13	34.30	34.48
7	38.43	38.63	38.82	39.02	39.22	39.42	39.62	39.82	40.02	40.22
8	43.92	44.15	44.37	44.60	44.83	45.05	45.28	45.51	45.74	45.97
9	49.41	49.67	49.92	50.17	50.43	50.68	50.94	51.20	51.46	51.72
10	54.91	55.19	55.47	55.75	56.04	56.32	56.61	56.89	57.18	57.47
11	60.40	60.70	61 01	61.32	61.64	61.95	62.27	62.57	62.89	63.21
12	65.89	66.22	66.56	66.90	67.24	67.58	67.93	68.26	68.61	68.96
13	71.38	71.74	72.11	72.47	72.85	73.21	73.59	73 95	74 33	74.71
14	76.87	77.26	77 65	78.05	78.45	78.84	79.25	79.64	80.05	80.45
15	82.36	82.78	83.20	83.62	84.06	84.48	84.91	85.33	85.77	86.20
16	87.85	88.30	88.75	89.20	89.66	90.11	90.57	91.02	91.48	91.95
17	93.34	93.82	94.29	94.77	95.26	95.74	96.23	96.71	97.20	97.69
18	98.83	99 34	99.84	100.35	100.87	101.37	101.89	102.40	102 92	103.44
19	104.32	104.80	105.39	105.92	106.47	107.00	107.55	108.09	108.64	109.19
20	109.82	110.38	110.94	111.50	112.08	112.64	113.22	113.78	114.36	114.94
21	115.31	115.89	116 48	117.07	117.08	118.27	118.88	119.46	120.07	120.68
22	120.80	121.41	122.03	122.65	123.28	123.90	124.54	125.15	125.79	126.42
23	126.29	126.93	127.58	128 22	128.89	129.53	130.20	130.84	131.51	132.18
24	131.78	132.45	133.12	133.80	134.49	135.16	135.86	136.53	137.23	137.92
25	137.27	137.97	138.67	139.37	140.10	140.80	141.52	142.22	142.95	143.67
26	142.76	143 49	144 22	144.95	145.70	146.43	147.18	147.91	148.66	149.42
27	148.25	149.01	149.76	150.52	151.30	152.06	152.84	153.60	154.38	155.16
28	153.74	154.53	155.31	156.10	156.91	157.69	158.50	159.29	160.10	160.91
29	159.23	160.05	160.86	161.67	162.51	163.32	164.16	164.98	165.82	166.66
30	164.73	165.57	166.41	167.25	168.12	168.96	169.83	170.67	171.54	172.41

40 Inches Diameter.

Depth	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	5.77	5.80	5.83	5.86	5.89	5.92	5.95	5.98	6.00	6.03
2	11.55	11.61	11.66	11.72	11.78	11.84	11.90	11.96	12.01	12.07
3	17.32	17.41	17.50	17.58	17.67	17.76	17.85	17.94	18.02	18.11
4	23.10	23.22	23.33	23.45	23.56	23.68	23.80	23.92	24.03	24.15
5	28.88	29.02	29.17	29.31	29.46	29.60	29.75	29.90	30.04	30.19
6	34.65	34.83	35.00	35.17	35.35	35.52	35.70	35 88	36.05	36.23
7	40.43	40.63	40.83	41.04	41.24	41.44	41.65	41.86	42.06	42.27
8	46.20	46.44	46.67	46.90	47.13	47.36	47.60	47.84	48.07	48 31
9	51.98	52.24	52.50	52.76	53 02	53.28	53.55	53.82	54.08	54.35
10	57.76	58.05	58.34	58.63	58.92	59.21	59.50	59.80	60.09	60.39
11	63.53	63.85	64.17	64.49	64.81	65.13	65.45	65.78	66.09	66.42
12	69.31	69.66	70.00	70 35	70.70	71.05	71.40	71.76	72.10	72.46
13	75.08	75.46	75.84	76.21	76.59	76.97	77.35	77.74	78.11	78.50
14	80.86	81.27	81.67	82.08	82.48	82.89	83.30	83.72	84.12	84 54
15	86.64	87.07	87.15	87.94	88.38	88.81	89.25	89.70	90.13	90.58
16	92.41	92.88	93.34	93.83	94.27	94.73	95.20	95.68	96.14	96.62
17	98.19	98.68	99.17	99.67	100.16	100.65	101.15	101.66	102.15	102.66
18	103.96	104.49	105.01	105 53	106.05	106.57	107.10	107.64	108.16	108.70
19	109.74	110.29	110.84	111.39	111.94	112.49	113.05	113.62	114.17	114.74
20	115.52	116.10	116.68	117.26	117.84	118.42	119.00	119.60	120.18	120.78
21	121.29	121.90	122.51	123.12	123.73	124.34	124.95	125.58	126.18	126.81
22	127 07	127.71	128.34	128.98	129.62	130.26	130.90	131.56	132.19	132.85
23	132.84	133.51	134.18	134.84	135.51	136.18	136.85	137.54	138.20	138.89
24	138.62	139.42	140.01	140.71	141.40	142.10	142.80	143.52	144.21	144.93
25	144.40	145.22	145.85	146.57	147.30	148.02	148.75	149.50	150.22	150.97
26	150.17	151.03	151.68	152.43	153.19	153.94	154.70	155.48	156.23	157.01
27	155.95	156.83	157.51	158.30	159.08	159.86	160.65	161.46	162.24	163.05
28	161.72	162.64	163.35	164.16	164.97	165.78	166.60	167.44	168.25	169.09
29	167.50	168.44	169.18	170.02	170.86	171.70	172.55	173.42	174.26	175.13
30	173.28	174.25	175.02	175.89	176.76	177.63	178.50	179.40	180.27	181.17

41 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	6.06	6.09	6.12	6.15	6.18	6.21	6.24	6.27	6.30	6.33
2	12.13	12.18	12.24	12.30	12.36	12.42	12.48	12.54	12.60	12.66
3	18.18	18.27	18.36	18.45	18.54	18.63	18.72	18.81	18.90	18.99
4	24.27	24.36	24.48	24.60	24.72	24.84	24.96	25.08	25.20	25 32
5	30.34	30.45	30.60	30.75	30.90	31.05	31.20	31.35	31.50	31.65
6	36.40	36.58	36.76	36 94	37.10	37.30	37.48	37.66	37 84	38.02
7	42.47	42.68	42.88	43.09	43.30	43.51	43.72	43.93	44.14	44.35
8	48.54	48.78	49.01	49.25	49.49	49.73	49.97	50.21	50.45	50.69
9	54.61	54.88	55.34	55 41	55.78	55.95	56.22	56.49	56.76	57 03
10	60.68	60.98	61.27	61.57	61.87	62.17	62.47	62.77	63.07	63.37
11	66.74	67.07	67.39	67.72	68.05	68.38	68.71	69.04	69.37	69.70
12	72.81	73.17	73.52	73.88	74.24	74.60	74.96	75.32	75.68	76.04
13	78.88	79.27	79.65	80.04	80.43	80.82	81.21	81.60	81.99	82.38
14	84.95	85.37	85.77	86.19	86.61	87.03	87.45	87.87	88.29	88.71
15	91.02	91.47	91.90	92.35	92.80	93.25	93.70	94.15	94.60	95.05
16	97.09	97.56	98.03	98.51	98.99	99.47	99.95	100.43	101.04	101.39
17	103.15	103.66	104.15	104.60	105.17	105.68	106.19	106.70	107.21	107.72
18	109.22	109.76	110.28	110.82	111.36	111.80	112.44	112.98	113.52	114.06
19	115.29	115.86	116.41	116.98	117.55	118.12	118.69	119.26	119.83	120.40
20	121.36	121.96	122.54	123.14	123.74	124.35	124.94	125.54	126.14	126.74
21	127.42	128.05	128.66	129.29	129.92	130.55	131.18	131.81	132.44	133.07
22	133.49	134.15	134.79	135.45	136.11	136.77	137.43	138.09	138.75	139.41
23	139.56	140.25	140.92	141.61	142.30	142.99	143.68	144.37	145.06	145.75
24	145.63	146.35	147.04	147.76	148.48	149.20	149.92	150.64	151.36	152.08
25	151.70	152.45	153.17	153.92	154.67	155.42	156.17	156.92	157.67	158.42
26	157.76	158.58	159.30	160.08	160.80	161.64	162.42	163.20	163.98	164.76
27	163.83	164.64	165.42	166.23	167.04	167.85	168.66	169.47	170.28	171.09
28	169.90	170 74	171.55	172.39	173 23	174.07	174.83	175.75	176.59	177.43
29	175.97	176.84	177.68	178.55	179.42	180.29	181.16	182.03	182.90	183.77
30	182.04	182.94	183.81	184.71	185.61	186.51	187.41	188.31	189.21	190.11

42 Inches Diameter.

Depth	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	6.36	6.39	6.42	6.45	6.49	6.52	6 55	6.58	6.61	6.64
2	12.73	12.79	12.85	12.91	12.98	13.04	13.10	13.16	13.22	13.28
3	19.10	19.19	19.28	19.37	19.47	19.56	19.65	19.74	19.83	19.93
4	25.47	25.59	25.71	25.83	25.96	26.08	26 20	26.32	26.45	26 57
5	31.84	31.99	32.14	32.29	32.45	32.60	32.75	32.91	33.06	33.22
6	38.20	38.38	38.57	38 75	38.94	39.12	39.30	39.49	39 67	39.86
7	44.47	44.78	45.00	45.21	45.43	45.64	45.85	46.07	46.29	46.50
8	50.94	51.18	51.43	51.67	51.92	52.16	52.40	52.65	52.90	53.15
9	57.31	57.58	57.86	58.13	58.41	58.68	58.95	59.22	59.51	59.79
0	63.68	63.98	64.29	64.59	64.90	65.20	65.51	65.82	66.13	66.44
1	70.04	70.37	70.71	71.04	71.39	71.72	72.06	72.40	72.74	73.08
2	76.41	76.77	77.14	77.50	77.88	78.24	78.61	78.98	79.35	79.72
3	82.78	83.17	83.57	83.96	84.37	84.76	85.16	85.56	85.96	86.37
4	89.15	89.57	90.00	90.42	90.86	91.28	91.71	92.14	92.58	93.01
5	95.52	95.97	96.43	96.88	97.35	97.80	98.26	98.73	99.19	99.66
6	101.88	102.36	102.86	103.34	103.84	104.32	104.81	105.31	105.80	106.30
7	108.25	108.76	109.29	109.80	110.13	110.84	111.36	111.89	112.42	112.94
8	114.62	115 16	115.74	116.26	116.82	117.36	117.91	118.47	119.07	119.59
9	120.99	121.56	122.15	122.72	123.31	123.88	124.46	125.05	125.64	126.23
0	127.36	127.96	128.58	129.18	129.80	130.40	131.02	131.64	132.26	132.88
1	133.72	134.35	135.00	135.63	136.29	136.92	137.57	138.22	138.87	139.52
2	140.09	140.75	141.43	142.09	142.78	143.44	144.12	144.80	145.48	146.16
3	146.64	147.15	147.86	148.55	149 27	149.96	150.67	151.38	152.09	152.81
4	152.83	153.55	154.29	155.01	155.76	156.48	157.22	157.96	158.71	159.45
5	159.20	159.95	160.50	161.25	162.25	163.00	163.75	164.50	165.25	166.00
6	165.36	166.14	166.92	167.70	168.74	169.52	170.30	171 08	171.86	172.64
7	171.72	172.53	173.34	174.15	175.23	176.04	176.85	177.66	178.47	179.28
8	178.08	178.92	179.76	180.60	181.72	182.56	183.40	184.24	185.08	185.92
9	184.44	185.31	186.18	187.05	188.21	189.08	189.95	190.82	191.69	192.56
0	190.80	191.70	192.60	193.50	194.70	195.60	196.50	197.40	198.30	199.20

43 Inches Diameter.

Depth	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	6.67	6.70	6.73	6.76	6.79	6.83	6.86	6.89	6.92	6.95
2	13.35	13.41	13.47	13.53	13.59	13.66	13.72	13.78	13.85	13 91
3	20.02	20.11	20.21	20.30	20.39	20.49	20.58	20.68	20 77	20 87
4	26.70	26.82	26.94	27.07	27.19	27.32	27.44	27.57	27.70	27.82
5	33.37	33.53	33.68	33.84	33.99	34.15	34.31	34.47	34.62	34.78
6	40.05	40.23	40.42	40.60	40.79	40.98	41.17	41.36	41.55	41.74
7	46.72	46.94	47.15	47.37	47.59	47.81	48.03	48.25	48.47	48.69
8	53.40	53.64	53.89	54.14	54.39	54.64	54.89	55.15	55.40	55.65
9	60.07	60.35	60.63	61.01	61.19	61.47	61.75	62.04	62 32	62.61
10	66.75	67.06	67.37	67.68	67.99	68.31	68.62	68.94	69.25	69.57
11	73.42	73.76	74.10	74.44	74.78	75.14	75.48	75.83	76.17	76.52
12	80.10	80.47	80.84	81.21	81.58	81.97	82.34	82.72	83.10	83.48
13	86.77	87.17	87.58	87.98	88.38	88.80	89.20	89.62	90.02	90.44
14	93.45	93.88	94.31	94.75	95.18	95.63	96.06	96.41	96.95	97.39
15	100.12	100.59	101.05	101.52	101.98	102.46	102.73	103.41	103.87	104.35
16	106.80	107.29	107.79	108.28	108.78	109.29	109.79	110.30	110.80	111.31
17	113 47	114.00	114.52	115.05	115.58	116.12	116 65	117.19	117.72	118.26
18	120.15	120.70	121.26	121.82	122.38	122.95	123.51	124.09	124.65	125.22
19	126.82	127.40	128.00	128.59	129.18	129.78	130.37	130.98	131.57	132.18
20	133.50	134.12	134.74	135.36	135.98	136.62	137.24	137.88	138.50	139.14
21	140.17	140.82	141.47	142.12	142.77	143.45	144.10	144.87	145.42	146.09
22	146.85	147.53	148.21	148.89	149.57	150.28	150.96	151.66	152.35	153.05
23	153.52	154.23	154.95	155.66	156.37	157.11	157.82	158.56	159.27	160.01
24	160.20	160.94	161.68	162.43	163.17	163.94	164.68	165.45	166.20	166.98
25	166.87	167.65	168.42	169.20	169.97	170.77	171.55	172.35	173.12	173.92
26	173.55	174.35	175.16	175.96	176.77	177.60	178.41	179.24	180.05	180.88
27	180.22	181.06	181.89	182.73	183.57	184.43	185.27	186.13	186.97	187.83
28	186.90	187.76	188.63	189.50	190.37	191.26	192.13	193.03	193.90	194.89
29	193.57	194.47	195.37	196.27	197.17	198.09	198.99	199.86	200.82	201.75
30	200.25	201.18	202.11	203.04	203.97	204.93	205.86	206.82	207.75	208.71

44 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	6.98	7.02	7.05	7.08	7.11	7.14	7.18	7.21	7.24	7.27
2	13.97	14.04	14.10	14.16	14.23	14 29	14.36	14.42	14.49	14.55
3	20.96	21.06	21.15	21.25	21.34	21.44	21.54	21.63	21.73	21.83
4	27.95	28.08	28.20	28.33	28.46	28.59	28.72	28.85	28.98	29.11
5	34.94	35.10	35.26	35.42	35.58	35.74	35.90	36.06	36.22	36.39
6	41.93	42.12	42.31	42.50	42.69	42.88	43.08	43.27	43.47	43.66
7	48.92	49.14	49.36	49.58	49.81	50.03	50.26	50.49	50.71	50.94
8	55.91	56.16	56.41	56.67	56.92	57.18	57.44	57.70	57.96	58.22
9	62.90	63.18	63.46	63.75	64.04	64.33	64.62	64.91	65.20	65.50
10	69.89	70.21	70.52	70.84	71.16	71.48	71.81	72.13	72.45	72.78
11	76.87	77.23	77.57	77.92	78.27	78.62	78.99	79.34	79.69	80.05
12	83.86	84.25	84.62	85.00	85.39	85.77	86 17	86 55	86.94	87.33
13	90.85	91.27	91.67	92.09	92 50	92.92	93.35	93.76	94.18	94.60
14	97.84	98.29	98.72	99.17	99.62	100.07	100.53	100.98	101.43	101.89
15	104.83	105.31	105.78	106.26	106.74	107.22	107.71	108.19	108.67	109.17
16	111.82	112.33	112.83	113.34	113.85	114.36	114.89	115.40	115.92	116.44
17	118.81	119.35	119.88	120.42	120.97	121.51	122.07	122.62	123.16	123.72
18	125.80	126.37	126.93	127.51	128.08	128.66	129.25	129.83	130.41	130.98
19	132.79	133.39	133.98	134.59	135.20	135.81	136.43	137.04	137.65	138.28
20	139.78	140.42	141.04	141.68	142.32	142.96	143.62	144.26	144.90	145.56
21	146.76	147.44	148.09	148.78	149.43	150.10	150.80	151.47	152.14	152.83
22	153.75	154.46	155.14	155.84	156.55	157.25	157.98	158.68	159.39	160.11
23	160.74	161.48	162.19	162.93	163.66	164.40	165.16	165.89	166.63	167.39
24	167.73	168.50	169.24	170.01	170.78	171.55	172.34	173.11	173.88	174.67
25	174.72	175.52	176.29	177.10	177.90	178.70	179.52	180.32	181.12	181.95
26	181.71	182.54	183.35	184.18	185.01	185.84	186.70	187.53	188.37	189.22
27	188.70	189.56	190.40	191.26	192.13	192.99	193.88	194.75	195.61	196.50
28	195 69	196.58	197.45	198.35	199.24	200.06	201.06	201.96	202.86	203.78
29	202.68	203.60	204.50	205.43	206.36	207.29	208.24	209.17	210.10	211.06
30	209.67	210.63	211.56	212.52	213.48	214.44	215.43	216.39	217.35	218.34

45 Inches Diameter.

Depth.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	7.31	7.34	7.37	7.40	7.44	7.47	7.50	7.53	7.57	7.60
2	14.62	14.68	14.74	14.80	14.88	14.94	15.00	15.06	15.14	15.20
3	21.93	22.02	22.11	22.20	22.32	22.41	22.50	22.59	22.71	22.80
4	29.24	29.36	29.48	29.60	29.76	29.88	30.00	30.12	30.28	30.40
5	36.55	36.70	36 85	37.00	37.20	37.35	37.50	37.65	37.85	38.00
6	43.86	44.05	44.25	44.44	44.64	44.83	45.03	45.23	45.43	45.63
7	51.17	51.39	51.62	51.85	52.08	52.31	52.54	52.77	53.00	53.23
8	58 48	58.73	59.00	59.26	59.52	59.78	60.04	60.31	60.57	60.84
9	65.79	66.07	66.37	66.67	66.96	67.25	67.55	67.85	68.14	68.44
10	73.10	73.42	73.75	74.08	74.41	74.73	75.06	75.39	75.72	76.05
11	80.41	80.76	81.12	81.48	81.85	82.20	82.56	82.92	83.29	83.65
12	87.72	88.10	88.50	88.89	89.29	89.67	90.07	90.46	90.86	91.26
13	95.03	95.44	95.87	96.30	96.73	97.14	97.57	98.00	98.43	98.86
14	102.34	102.78	103.25	103.71	104.17	104.62	105.08	105.54	106.00	106.47
15	109.65	110.13	110.62	111.12	111.61	112.09	112.59	113.08	113.58	114.07
16	116.96	117.47	118.00	118.52	119.05	119.56	120.09	120.62	121.15	121.68
17	124.27	124 81	125.37	125.93	126.39	127.04	127.60	128.16	128.72	129.28
18	131.58	132.15	132.75	133.34	133 93	134.51	135.10	135.70	136.21	136.89
19	138.89	139.49	140.12	140.75	141.37	141.98	142.61	143.24	143.86	144.49
20	146.20	146.84	147.50	148.16	148.82	149.46	150.12	150.78	151.44	152.10
21	153.51	154.18	154.87	155.56	156.26	156.93	157.62	158.31	159.01	159.70
22	160.82	161.52	162.25	162.97	163.70	164.40	165.13	165.85	166.58	167.31
23	168.13	168.56	169.62	170.38	171.14	171.87	172.63	173.39	174 15	174.91
24	175.34	176.20	177.00	177.79	178.58	179.35	180.14	180.93	181.72	182.52
25	182.75	183.55	184.37	185.20	186.02	186.82	187.65	188.47	189.30	190.12
26	190.06	190.89	191.75	192.60	193.46	194.29	195.15	196.01	196.87	197.73
27	197.37	198.83	199.12	200.01	200.90	201.77	202.66	203.55	204.44	205.33
28	204.68	205.57	206.50	207.42	208.34	209.24	210.16	211.09	212.01	212.94
29	211.99	212.91	213.77	214.83	215.78	216.71	217.67	218.63	219.58	220.54
30	219.30	220.26	221.25	222.24	223.23	224.19	225.18	226.17	227.16	228.15

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TABLE

SHEWING THE

AREAS OF CIRCLES

IN

Gallons and Parts,

AT ONE INCH DEEP,

FROM FORTY-FIVE INCHES DIAMETER, TO ONE HUNDRED AND TWENTY.

IN GALLONS.

Diam.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
46	7.639	7.672	7.705	7.739	7.772	7.805	7.839	7.873	7.907	7.940
47	7.974	8.008	8.042	8 076	8.111	8.145	8.179	8.214	8.248	8.283
48	8.317	8.352	8.387	8.422	8.456	8.491	8.526	8 562	8.597	8.632
49	8.667	8.703	8.738	8.774	8.809	8.845	8.881	8 917	8.953	8.989
50	9 025	9.061	9.097	9.133	9.170	9.206	9.243	9.279	9.316	9.353
51	9.389	9.426	9.463	9.500	9.537	9.574	9.612	9.649	9.686	9.724
52	9.761	9.799	9.836	9.874	9.912	9.950	9.988	10.026	10.064	10.102
53	10.140	10.179	10.217	10.255	10.294	10.333	10.371	10.410	10.449	10.487
54	10.527	10.567	10.605	10.644	10.683	10.722	10.762	10.801	10.841	10 885
55	10.920	10 960	11.000	11.040	11.079	11.120	11.160	11.200	11.240	11.280
56	11.321	11.361	11.402	11.442	11.483	11.524	11 565	11.605	11.646	11.688
57	11.729	11.770	11.811	11.852	11 894	11.935	11.977	12.019	12.060	12.102
58	12.144	12.186	12.228	12.270	12.312	12.354	12.396	12 439	12.481	12.524
59	12.566	12.609	12.652	12.694	12.737	12.780	12.823	12.866	12 909	12.953
60	12.996	13.039	13.082	13.126	13.170	13.213	13.257	13.301	13.344	13.388
61	13.433	13.477	13.521	13.565	13.609	13 654	13.698	13.743	13.787	13.832
62	13.877	13.921	13.966	14.011	14.056	14.101	14.146	14.192	14.237	14.282
63	14.328	14.373	14.419	14.465	14.510	14.556	14.602	14.648	14.694	14.740
64	14.786	14.833	14.879	14.925	14.972	15.018	15.065	15.111	15.158	15.205
65	15.252	15.299	15.346	15.393	15.440	15.488	15.535	15.582	15.630	15.677
66	15 725	15.773	15 820	15.868	15.916	15.964	16.012	16.060	16.108	16.157
67	16.205	16 253	16.302	16.351	16.399	16.448	16.497	16.545	16.594	16.643
68	16.692	16.741	16.791	16.840	16.889	16.939	16.988	17.038	17.088	17.137
69	17.187	17.237	17.287	17 337	17.387	17.437	17.487	17.538	17.588	17.638
70	17.689	17.739	17.790	17.841	17.892	17.942	17.993	18.044	18.095	18.147
71	18.198	18.249	18.300	18.352	18.403	18.455	18.507	18.558	18.610	18.662
72	18.714	18.766	18.818	18.870	18.922	18.975	19.027	19.080	19.132	19.185
73	19.237	19.290	19 344	19.396	19.449	19.502	19.555	19.608	19.661	19.715
74	19.768	19 822	19 875	19.929	19.982	20.036	20.090	20.144	20.198	20.252
75	20.306	20.360	20.414	20.469	20.523	20.578	20.632	20.687	20.742	20.796

In Gallons.

.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
.851	20.906	20.961	21.016	21.071	21.126	21.182	21.237	21 292	21.348
.403	21.459	21.515	21.571	21.626	21.682	21.738	21.794	21.851	21.907
.963	22.019	22.076	22.132	22.189	22.245	22.302	22.359	22.416	22.473
.530	22.587	22.644	22.701	22.759	22.816	22.873	22.931	22.988	23.046
.104	23.162	23.219	23.277	23.335	23.393	23.452	23.510	23.568	23.627
.685	23.744	23.802	23.861	23.920	23.978	24.037	24.096	24 155	24.214
.273	24.333	24.392	24.451	24.511	24.570	24.630	24.690	24.749	24.809
.869	24.920	24.989	25.049	25.109	25.170	25.230	25.290	25.351	25.411
.472	25.533	25.593	25.654	25.715	25.776	25.837	25 898	25.959	26.021
.082	26.143	26.205	26.266	26.328	26.390	26.452	26.513	26.575	26.637
.699	26.761	26.824	26.886	26.948	27.011	27.073	27.136	27.198	27.261
.324	27.387	27.450	27.513	27.576	27.639	27.702	27.765	27 829	27.892
.956	28.019	28.083	28.146	28.210	28.274	28.338	28.402	28.466	28.530
.595	28.659	28.723	28.788	28.852	28.917	28.981	29.046	29.111	29.176
.241	29.306	29.371	29.436	29 501	29.567	29.632	29.697	29.763	29 829
.894	29.960	30.026	30.092	30.150	30.226	30.290	30.356	30.432	30.488
.555	30.621	30.688	30 754	30.821	30.888	30.955	31.022	31.892	31.156
.223	31.290	31.357	31.424	31.492	31.559	31.627	31.694	31.762	31.830
.898	31.966	32.034	32.102	32.170	32.238	32.306	32.375	32.443	32.511
.580	32.647	32.717	32.786	32.855	32.924	32.992	33.062	33.131	33.200
.270	33.339	33.408	33.478	33.547	33.617	33.687	33.757	33.826	33.896
.966	34.036	34.107	34.177	34.247	34.317	34.388	34.458	34.529	34.600
.679	34.741	34.812	34.883	34.954	35.025	35.096	35.167	35.239	35.310
.381	35.453	35.525	35.596	35.668	35.740	35.812	35.884	35.956	36.028
.100	36.172	36.244	36.317	36.389	36.462	36.534	36.607	36.680	36.753
.825	36.898	36.971	37.045	37.118	37.191	37.264	37.338	37.411	37 485
.558	37.632	37.706	37.780	37.853	37.927	38.001	38.076	38.150	38.224
.298	38.373	38.447	38.522	38.596	38.671	38.746	38.821	38.896	38.971
.045	39.121	39.191	39.271	39.346	39.432	39.497	39.573	39.649	39.724
.800	39.876	39.952	40.028	40.104	40.180	40.256	40.332	40.409	40.485

IN GALLONS.

Diam.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
106	40.562	40.638	40.715	40.792	40.868	40.945	41.023	41.099	41.176	41.2
107	41.331	41.408	41.485	41.563	41.640	41.718	41.769	41.873	41.951	42.0
108	42.107	42.185	42.263	42.341	42.419	42.498	42.576	42.654	42.733	42.8
109	42.890	42.969	43.048	43.127	43.206	43.285	43.364	43.443	43.522	43 6
110	43.681	43.760	43.840	43.919	44 000	44.079	44.159	44.239	44.318	44.3
111	44.479	44.559	44.639	44.719	44.800	44.880	44.961	45.041	45.122	45.2
112	45.284	45.365	45.446	45.527	45.608	45.689	45.770	45.851	45.933	46.0
113	46.096	46.178	46.259	46.341	46.423	46.503	46.587	46.669	46.751	46.8
114	46.915	46.998	47.080	47.163	47.245	47.328	47.411	47.493	47.576	47.6
115	47.742	47.825	47.908	47.991	48.075	48.158	48.242	48.325	48.409	48.4
116	48.576	48.660	48.744	48.828	48.912	48.996	49.080	49.164	49.248	49.3
117	49.417	49.502	49.586	49.671	49.756	49.840	49.925	50.010	50.095	50.1
118	50.265	50.351	50.436	50.521	50.607	50.692	50.778	50.864	50.949	51.0
119	51.121	51.207	51.293	51.379	51.465	51.552	51.638	51.724	51.811	51.8
120	51.984	52.070	52.157	52.244	52.331	52.418	52.505	52.592	52.679	52.7

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TABLE

SHEWING THE

AREAS OF SQUARES

IN

Gallons

AND

DECIMILLESIMAL PARTS.

CALCULATED TO

EVERY TENTH PART AND QUARTER OF AN INCH OF THE SIDE,

FROM ONE TO ONE HUNDRED INCHES.

IN GALLONS.

Side.	.0	.1	.2	.25	3·	.4
1	.004595	.00556	.006617	.007180	.007766	.009007
2	.0183	.0202	.0222	.0232	.0243	.0264
3	.0413	.0441	.0470	.0485	.0500	.0531
4	.0735	.0772	.0810	.0830	.0849	.0889
5	.1148	.1195	.1243	.1266	.1290	.1340
6	.1654	.1710	.1766	.1795	.1823	.1882
7	.2251	.2316	.2382	.2415	.2448	.2516
8	.2941	.3015	.3090	.3127	.3165	.3242
9	.3722	.3805	.3889	.3932	.3974	.4060
10	.4595	.4687	.4781	.4828	.4875	.4970
11	.5560	.5662	.5764	.5816	.5868	.5972
12	.6617	.6728	.6840	.6896	.6952	.7066
13	.7766	.7886	.8007	.8068	.8129	.8251
14	.9007	.9136	.9266	.9331	.9397	.9529
15	1.0340	1.0478	1.0617	1.0687	1.0757	1.0898
16	1.1764	1.1912	1.2060	1.2135	1.2210	1.2360
17	1.3281	1.3438	1.3595	1.3674	1.3754	1.3913
18	1.4889	1.5055	1.5222	1.5306	1.5390	1.5558
19	1.6590	1.6765	1.6941	1.7029	1.7118	1.7295
20	1.8382	1.8566	1.8751	1.8844	1.8937	1.9125
21	2.0266	2.0460	2.0654	2.0751	2.0849	2.1045
22	2.2242	2.2445	2.2649	2.2751	2.2853	2.3058
23	2.4310	2.4522	2.4735	2.4842	2.4949	2.5163
24	2.6470	2.6691	2.6913	2.7024	2.7136	2.7360
25	2.8722	2.8952	2.9183	2.9299	2.9415	2.9648
26	3.1066	3.1305	3.1545	3.1666	3.1787	3.2029
27	3.3501	3.3750	3.3999	3.4125	3.4250	3.4501
28	3.6029	3.6289	3.6546	3.6675	3.6806	3.7067
29	3.8648	3.8915	3.9183	3.9316	3.9452	3.9722
30	4.1360	4.1636	4.1913	4.2052	4.2191	4.2470

In Gallons.

Side.	·5	·6	·7	·75	·8	·9
1	.01034	.0117	.0132	.0140	.0148	.0165
2	.0287	.0310	.0335	.0347	0360	.0386
3	.0562	.0595	.0629	.0646	.0663	.0699
4	.0930	.0972	.1015	.1036	.1058	.1103
5	.1390	.1441	.1493	.1519	.1546	.1599
6	.1941	.2002	.2063	.2093	.2125	.2187
7	.2585	.2654	.2724	.2760	.2795	.2868
8	.3320	.3399	.3477	3518	.3558	.3640
9	.4147	.4235	.4323	.4368	.4413	.4504
10	.5066	.5163	.5261	.5310	.5360	5460
11	.6077	.6183	.6290	.6344	.6398	.6507
12	.7180	.7295	.7412	.7470	.7529	.7647
13	.8375	.8500	.8625	.8688	.8751	.8879
14	.9662	.9795	.9930	.9998	1.0066	1.0202
15	1.1040	1.1183	1.1327	1.1399	1.1472	1.1618
16	1.2511	1.2663	1.2816	1.2893	1.2970	1.3125
17	1.4074	1 4235	1.4397	1.4478	1.4560	1.4724
18	1.5728	1.5898	1.6070	1.6156	1.6242	1.6415
19	1.7474	1.7654	1.7835	1.7925	1.8016	1.8198
20	1.9312	1 9501	1.9691	1.9786	1.9882	2.0073
21	2.1243	2.1441	2.1640	2.1740	2.1840	2.2040
22	2 3265	2.3472	2 3680	2.3785	2.3889	2.4099
23	2.5379	2.5595	2.5812	2.5921	2.6031	2.6250
24	2.7585	2.7810	2.8037	2.8150	2.8264	2.8493
25	2.9882	3 0117	3.0353	3.0471	3.0589	3.0827
26	3.2272	3.2516	3.2761	3.2884	3.3007	3.3254
27	3.4754	3 5007	3.5261	3.5388	3.5516	3.5772
28	3.7328	3.7591	3.7854	3.7985	3.8118	3.8384
29	3.9995	4.0264	4.0537	4 0673	4.0810	4.1085
30	4.2750	4.3031	4.3312	4.3454	4.3595	4.3879

In Gallons.

Side.	.0	.1	2.	.25	.3	.4
31	4 4163	4.4448	4.4735	4.4878	4.5022	4.5310
32	4.7058	4.7353	4.7648	4.7796	4.7945	4.8242
33	5 0045	5.0349	5.0654	5 0807	5.0959	5.1266
34	5.3126	5.3437	5.3751	5.3909	5.4066	5.4382
35	5.6295	5.6618	5.6941	5.7103	5.7265	5.7590
36	5.9558	5.9890	6.0222	6.0388	6.0555	6.0889
37	6.2913	6 3254	6.3595	6.3766	6.3937	6.4281
38	6.6360	6.6710	6.7060	6 7236	6.7412	6.7764
39	6.9898	7.0257	7.0617	7.0797	7.0978	7.1340
40	7.3529	7.3897	7.4266	7.4451	7.4636	7.5007
41	7.7251	7.7629	7.8007	7.8196	7.8386	7.8766
42	8.1066	8.1452	8.1840	8.2034	8.2228	8.2617
43	8.4972	8.5368	8 5764	8.5963	8.6162	8.6560
44	8.8970	8.9375	8.9781	8.9984	9.0188	9.0595
45	9.3060	9.3474	9.3889	9.4097	9.4305	9 4722
46	9.7242	9.7666	9 8090	9.8302	9.8515	9.8941
47	10.1516	10.1949	10.2382	10.2599	10.2816	10.3251
48	10.5882	10.6323	10.6766	10.6988	10.7210	10.7654
49	11.0340	11.0790	11.1242	11.1468	11.1695	11.2148
50	11.4889	11.5349	11.5810	11.6041	11.6272	11.6735
51	11.9531	12.0000	12.0470	12.0705	12.0941	12.1413
52	12 4264	12.4743	12.5222	12 5462	12.5702	12.6184
53	12.9090	12.9577	13.0066	13.0310	13.0555	13 1045
54	13.4007	13 4504	13.5001	13.5251	13.5500	13.6000
55	13 9016	13.9522	14.0029	14.0283	14.0537	14.1045
56	14.4117	14.4632	14.5148	14.5407	14.5665	14.6183
57	14.9310	14 9835	15.0360	15.0623	15.0886	15.1413
58	15 4595	15 5129	15 5663	15.5931	15.6199	15.6735
59	15.9972	16.0515	16.1058	16.1330	16.1603	16.2148
60	16.5441	16.5993	16.6545	16.6822	16.7099	16.7654

IN GALLONS.

Side.	·5	.6	·7	·75	.8	·9
31	4·5599	4.5889	4.6180	4.6326	4.6472	4.6765
32	4.8540	4.8840	4 9140	4.9290	4.9441	4.9743
33	5.1573	5.1882	5.2191	5.2346	5.2501	5.2812
34	5.4698	5.5016	5.5335	5 5494	5.5654	5.5974
35	5·7915	5.8242	5.8570	5 8734	5.8898	5.9228
36	6.1224	6.1560	6.1897	6.2066	6.2235	6.2574
37	6.4625	6.4970	6.5316	6.5490	6.5663	6.6011
38	6.8118	6.8472	6.8827	6.9005	6.9183	6.9540
39	7.1702	7.2066	7.2430	7.2613	7.2795	7.3162
40	7.5379	7.5751	7.6125	7 6312	7.6500	7.6875
41	7.9147	7.9529	7.9912	8.0103	8 0296	8.0680
42	8.3007	8 3398	8.3790	8.3987	8.4183	8.4577
43	8.6960	8.7360	8.7761	8 7962	8.8163	8.8566
44	9.1004	9.1413	9.1824	9.2029	9.2235	9.2647
45	9.5140	9.5558	9 5978	9.6188	9 6399	9.6820
46	9.9368	9 9796	10 0224	10 0439	10.0654	10.1085
47	10.3688	10.4125	10.4563	10.4782	10.5001	10.5441
48	10.8099	10.8545	10 8993	10.9217	10.9441	10.9890
49	11.2603	11.3058	11.3515	11.3745	11.3972	11.4430
50	11.7199	11.7663	11 8129	11.8362	11.8595	11.9062
51	12.1886	12 2360	12.2835	12.3072	12.3310	12.3787
52	12.6666	12.7149	12.7633	12.7875	12.8117	12.8603
53	13.1537	13.2029	13 2522	13.2769	13.3016	13.3511
54	13 6500	13.7001	13.7504	13.7755	13.8007	13.8511
55	14.1555	14.2066	14 2577	14.2833	14.3090	14.3603
56	14.6702	14.7222	14.7743	14 8003	14.8264	14.8787
57	15.1941	15.2470	15.3000	15 3265	15.3531	15.4062
58	15.7272	15.7810	15.8349	15.8619	15.8889	15.9430
59	16.2695	16.3242	16.3790	16.4065	16.4340	16.4890
60	16.8210	16.8766	16 9324	16 9603	16.9882	17.0441

In Gallons.

Side.	.0	.1	.2	.25	.3	.4
61	17.1001	17.1562	17.2125	17.2406	17.2687	17.3251
62	17.6654	17.7224	17.7796	17.8081	17.8368	17.8941
63	18.2398	18.2978	18 3558	18.3849	18.4140	18.4722
64	18.8235	18.8824	18.9413	18.9708	19.0004	19.0595
65	19.4163	19.4761	19.5360	19.5660	19 5960	19.6560
66	20 0183	20.0791	20.1399	20.1703	20.2007	20.2617
67	20.6296	20.6912	20.7529	20.7838	20.8147	20.8766
68	21.2500	21.3125	21.3751	21.4065	21.4379	21.5007
69	21.6795	21.9430	22.0066	22.0 84	22.0702	22.1340
70	22.5183	22.5827	22.6472	22.6795	22.7118	22.7764
71	23.1663	23.2316	23.2970	23.3297	23.3625	23.4281
72	23.8235	23.8897	23.9560	23.9892	24.0224	24.0889
73	24.4898	24.5570	24.6242	24.6574	24.6915	24.7590
74	25.1654	25.2335	25.3016	25.3357	25.3698	25.4382
75	25.8501	25.9191	25.9882	26.0228	26.0573	26.1266
76	26.5441	26.6140	26.6840	26.7190	26.7540	26 8242
77	27.2472	27.3180	27.3889	27.4244	27.4599	27.5310
78	27.9595	28.0312	28.1031	28.1390	28.1750	28 2470
79	28.6810	28.7537	28.8264	28.8628	28.8993	28.9722
80	29.4117	29.4853	29.5590	29.5958	29.6327	29.7066
81	30.1516	30.2261	30.3007	30.3380	30.3754	30.4501
82	30.9007	30.9761	31.0516	31.0894	31.1272	31.2029
83	31.6590	31.7353	31.8117	31.8500	31.8882	31.9648
84	32.4264	32.5037	32.5810	32 6197	32.6585	32.7360
85	33.2031	33.2813	33.3595	33.3987	33.4379	33.5163
86	33.9889	34.0680	34.1472	34 1868	34.2265	34.3058
87	34 7840	34.8640	34.9441	34.9842	35.0243	35.1045
88	35.5882	35.6691	35.7501	35.7907	35.8313	35.9125
89	36.4016	36 4835	36.5654	36.6064	36.6474	36.7296
90	37.2242	37.3070	37.3898	37.4313	37.4728	37.5558

IN GALLONS.

Side.	·5	·6	·7	·75	·8	·9
61	17.3816	17.4382	17.4949	17.5232	17.5516	17.6085
62	17.9515	18.0090	18.0665	18.0954	18.1242	18.1820
63	18.5305	18.5889	18.6474	18.6767	18.7060	18.7647
64	19.1188	19.1781	19.2375	19.2672	19.2970	19.3566
65	19.7162	19.7764	19.8368	19.8670	19.8972	19.9577
66	20 3228	20.3840	20.4452	20.4759	20.5066	20.5680
67	20.9386	21.0007	21.0629	21.0940	21.1251	21.1875
68	21.5636	21.6266	21.6897	21.7213	21.7529	21 8162
69	22.1978	22.2617	22.3257	22.3578	22.3898	22.4540
70	22.8412	22.9060	22.9710	23.0035	23.0360	23.1011
71	23.4937	23.5595	23.6254	23.6583	23.6913	23.7573
72	24.1555	24.2222	24.2890	24.3224	24.3558	24.4228
73	24.8265	24.8941	24.9618	24.9956	25.0295	25.0974
74	25 5066	25.5751	25.6437	25.6781	25.7124	25.7812
75	26.1960	26.2654	26.3349	26.3697	26.4045	26.4743
76	26.8945	26.9648	27.0353	27.0706	27.1058	27.1765
77	27 6022	27.6735	27.7448	27.7806	27.8163	27.8879
78	28.3191	28.3913	28.4636	28.4998	28.5360	28.6084
79	29.0452	29.1183	29 1915	29.2282	29.2648	29.3382
80	29.7805	29.8545	29.9287	29.9658	30.0029	30.0772
81	30.5250	30.6000	30.6750	30.7126	30.7501	30.8254
82	31.2787	31.3545	31.4305	31.4685	31.5066	31.5827
83	32.0415	32.1183	32.1952	32.2337	32.2722	32.3493
84	32.8136	32.8913	32.9691	33.0080	33.0470	33.1250
85	33.5949	33.6735	33.7522	33.7916	33.8310	33.9099
86	34.3853	34.4648	34.5445	34.5843	34.6242	34.7040
87	35.1849	35.2654	35.3460	35.3863	35.4266	35.5074
88	35.9938	36.0751	36.1566	36.1974	36 2382	36.3199
89	36.8118	36.8941	36.9765	37.0177	37 0590	37.1415
90	37.6390	37.7222	37.8055	37.8472	37.8889	37.9724

In Gallons

Side.	.0	.1	.2	.25	.3	.4
91	38.0560	38.1397	38.2235	38 2654	38.3074	38.3913
92	38.8970	38.9816	39.0663	39.1087	39 1511	39.2360
93	39.7472	39.8327	39.9183	39.9612	40.0041	40.0899
94	40.6066	40.6930	40.7796	40.8228	40.8662	40.9529
95	41.4751	41.5625	41.6500	41.6937	41.7375	41.8251
96	42.3529	42.4412	42.5295	42.5738	42.6180	42.7066
97	43.2398	43.3290	43.4183	43.4630	43.5077	43.5972
98	44 1360	44.2261	44.3163	44.3615	44.4066	44.4970
99	45.0413	45 1324	45.2235	45.2691	45.3147	45.4060
100	45.9558	46.0478	46.1399	46.1859	46.2320	46.3242

IN GALLONS.

Side.	·5	·6	·7	·75	·8	·9
91	38.4754	38.5595	38.6438	38.6859	38.7281	38.8125
92	39.3210	39.4060	39.4912	39.5338	39.5764	39.6618
93	40.1757	40.2617	40.3478	40.3909	40.4340	40.5202
94	41.0397	41.1266	41.2136	41.2571	41.3007	41.3879
95	41.9129	42.0007	42.0886	42.1326	42.1766	42.2647
96	42.7952	42.8840	42.9728	43.0172	43.0617	43.1507
97	43.6868	43.7764	43.8662	43.9111	43.9560	44.0460
98	44.5875	44.6781	44.7688	44.8141	44.8595	44.9504
99	45.4974	45.5889	45.6805	45.7263	45.7722	45.8640
100	46.4166	46.5090	46.6015	46.6478	46.6941	46.7868

A TABLE of Allowance to Common Brewers of 2 Gallons in 22 for Ale.

Gall.	Ale.	Gall.	Ale.	Gall.	Ale.	Gall.	Ale.
1	—.09	36	3.27	71	6.45	700	63.63
2	—.18	37	3.36	72	6.54	800	72.72
3	—.27	38	3 45	73	6.63	900	81.81
4	—.36	39	3 54	74	6.72	1000	90.90
5	—.45	40	3.63	75	6.81	2000	181.81
6	— 54			76	6.90	3000	272.72
7	—.63	41	3.72	77	7.00	4000	363.62
8	—.72	42	3.81	78	7.09	5000	454.52
9	—.81	43	3.90	79	7.18	6000	545.42
10	—.90	44	4.00	80	7.27	7000	636.32
		45	4.09			8000	727 22
11	1.00	46	4.18	81	7.36	9000	818.12
12	1 09	47	4.27	82	7.45	10000	909.09
13	1.18	48	4.36	83	7.54	11000	999.92
14	1 27	49	4.45	84	7.63	12000	1090.82
15	1.36	50	4.54	85	7.72	13000	1181 72
16	1.45			86	7.81	14000	1272.62
17	1.54	51	4.63	87	7.90	15000	1363.52
18	1.63	52	4.72	88	8.00	16000	1454.42
19	1.72	53	4 81	89	8.09	17000	1545 32
20	1.81	54	4.90	90	8.18	18000	1636.22
		55	5.00			19000	1727.12
21	1.90	56	5.09	91	8.27	20000	1818.02
22	2.00	57	5.18	92	8.36	30000	2727.04
23	2.09	58	5.27	93	8.45	40000	3636 06
24	2.18	59	5.36	94	8.54	50000	4545 45
25	2.27	60	5.45	95	8.63	60000	5454.54
26	2.36			96	8.72	70000	6363.63
27	2.45	61	5.54	97	8.81	80000	7272.72
28	2.54	62	5.63	98	8.90	90000	8181.81
29	2.63	63	5.72	99	9.00	100000	9090.90
30	2.72	64	5.81	100	9.09	200000	18181.80
		65	5.90			300000	27272.70
31	2 81	66	6.00	200	18.18	400000	36363.60
32	2.90	67	6.09	300	27.27	500000	45454.50
33	3.00	68	6.18	400	36.36		
34	3.09	69	6 27	500	45.45		
35	3.18	70	6.36	600	54.54		

A TABLE of Allowance to Common Brewers of 2½ Gallons in 23 for Beer X & VI.

Gall.	Beer.	Gall.	Beer.	Gall.	Beer.	Gall.	Beer.
1	-.10	36	3.91	71	7.71	700	76.09
2	-.21	37	4.02	72	7.82	800	87.96
3	-.32	38	4.13	73	7.93	900	97.83
4	-.43	39	4.23	74	8.04	1000	108.69
5	-.54	40	4.34	75	8 15	2000	217.39
6	-.65			76	8 26	3000	326.08
7	-.76	41	4.45	77	8.36	4000	434.77
8	-.86	42	4.56	78	8.47	5000	543.46
9	-.97	43	4.67	79	8.58	6000	652.15
10	1.08	44	4.78	80	8.69	7000	760.84
		45	4.89			8000	869.53
11	1.19	46	5.00	81	8.80	9000	978.22
12	1.30	47	5.10	82	8.91	10000	1086.91
13	1.41	48	5.21	83	9.02	11000	1195.60
14	1 52	49	5.32	84	9 13	12000	1304.29
15	1 63	50	5.43	85	9.23	13000	1412.98
16	1.74			86	9.34	14000	1521.67
17	1.84	51	5.54	87	9.45	15000	1630.36
18	1.95	52	5.65	88	9 56	16000	1739.05
19	2.06	53	5.76	89	9.67	17000	1847.74
20	2.17	54	5.86	90	9.78	18000	1956.43
		55	5.97			19000	2065.12
21	2.28	56	6.08	91	9.89	20000	2173.81
22	2.39	57	6 19	92	10 00	30000	3260.72
23	2.50	58	6.30	93	10.10	40000	4347 63
24	2.60	59	6.41	94	10.21	50000	5434.54
25	2.71	60	6.52	95	10 32	60000	6521.45
26	2.82			96	10.43	70000	7608.36
27	2.93	61	6.63	97	10.54	80000	8695.27
28	3.04	62	6.74	98	10.65	90000	9782.18
29	3.15	63	6 84	99	10.76	100000	10869.09
30	3.26	64	6.95	100	10.86		
		65	7.06				
31	3.36	66	7.17	200	21.74		
32	3.47	67	7.28	300	32.61		
33	3.58	68	7 39	400	43.48		
34	3.69	69	7.50	500	54.35		
35	3.80	70	7 60	600	65.22		

A MONEY TABLE for ALE, in which the Net Hereditary Revenue and additional Duties are calculated and proportioned to the Gallon of 217.6 Cubic Inches: Used in Dublin.

Gall.	Excise.			Gall.	Excise.			Gall.	Excise.				Gall.	Excise.		
	s.	d.			s.	d.			l.	s.	d.			l.	s.	d.	
1	—	1¼	584	36	4	2¼	024	71	—	8	3	464	700	4	1	5	800
2	—	2¾	168	37	4	3½	608	72	—	8	4½	048	800	4	13	—¾	200
3	—	4	752	38	4	5	192	73	—	8	5¾	632	900	5	4	8¼	600
4	—	5½	336	39	4	6¼	776	74	—	8	7¼	216	1000	5	16	4	—
5	—	6¾	920	40	4	7¾	360	75	—	8	8½	800	1100	6	7	11½	400
6	—	8¼	504	41	4	9	944	76	—	8	10	384	1200	6	19	7	800
7	—	9¾	088	42	4	10½	528	77	—	8	11¼	968	1300	7	11	2¾	200
8	—	11	672	43	5	—	112	78	—	9	—¾	552	1400	8	2	10¼	600
9	1	—½	256	44	5	1¼	696	79	—	9	2¼	130	1500	8	14	6	—
10	1	1¾	840	45	5	2¾	280	80	—	9	3½	720	1600	9	6	1½	400
11	1	3¼	424	46	5	4	864	81	—	9	5	304	1700	9	17	9	800
12	1	4¾	008	47	5	5½	448	82	—	9	6¼	888	1800	10	9	4¾	200
13	1	6	592	48	5	7	032	83	—	9	7¾	472	1900	11	1	—¼	600
14	1	7½	176	49	5	8¼	616	84	—	9	9¼	056	2000	11	12	8	—
15	1	8¾	760	50	5	9¾	200	85	—	9	10½	640	2100	12	4	3½	400
16	1	10¼	344	51	5	11	784	86	—	10	—	224	2200	12	15	11	800
17	1	11½	928	52	6	—½	368	87	—	10	1¼	808	2300	13	7	6¾	200
18	2	1	512	53	6	1¾	952	88	—	10	2¾	392	2400	13	19	2¼	600
19	2	2½	096	54	6	3¼	536	89	—	10	4	976	2500	14	10	10	—
20	2	3¾	680	55	6	4¾	120	90	—	10	5½	560	2600	15	2	5½	400
21	2	5¼	264	56	6	6	704	91	—	10	7	144	2700	15	14	1	800
22	2	6½	848	57	6	7½	288	92	—	10	8¼	728	2800	16	5	8¾	200
23	2	8	432	58	6	8¾	872	93	—	10	9¾	312	2900	16	17	4¼	600
24	2	9½	016	59	6	10¼	456	94	—	10	11	896	3000	17	9	—	—
25	2	10¾	600	60	6	11¾	040	95	—	11	—½	480	3100	18	—	7½	400
26	3	—¼	184	61	7	1	624	96	—	11	2	064	3200	18	12	3	800
27	3	1½	768	62	7	2½	208	97	—	11	3¼	648	3300	19	3	10¾	200
28	3	3	352	63	7	3¾	792	98	—	11	4¾	232	3400	19	15	6¼	600
29	3	4¼	936	64	7	5¼	386	99	—	11	6	816	3500	20	7	2	—
30	3	5¾	520	65	7	6½	960	100	—	11	7½	400	3600	20	18	9½	400
31	3	7¼	104	66	7	8	544	200	1	3	3	800	3700	21	10	5	800
32	3	8½	688	67	7	9½	128	300	1	14	10¾	200	3800	22	2	—¾	200
33	3	10	272	68	7	10¾	712	400	2	6	6¼	600	3900	22	13	8¼	600
34	3	11¼	856	69	8	—¼	296	500	2	18	2	—	4000	23	5	4	—
35	4	—¾	440	70	8	1½	880	600	3	9	9½	400	4100	23	16	11½	400

A MONEY TABLE for ALE, in which the Net Hereditary Revenue and additional Duties are calculated and proportioned to the Gallon of 217.6 Cubic Inches: Uſed in Dublin.

Gall.	Excise. l.	s.	d.		Gall.	Excise. l.	s.	d.		Gall.	Excise. l.	s.	d.	
4200	24	8	7	800	7700	44	15	9	800	22000	127	19	4	—
4300	25	—	2¾	200	7800	45	7	4¾	200	23000	133	15	8	—
4400	25	11	10¼	600	7900	45	19	—¼	600	24000	139	12	—	—
4500	26	3	6	—	8000	46	10	8	—	25000	145	8	4	—
4600	26	15	1½	400	8100	47	2	3½	400	26000	151	4	8	—
4700	27	6	9	800	8200	47	13	11	800	27000	157	1	—	—
4800	27	18	4¾	200	8300	48	5	6¾	200	28000	162	17	4	—
4900	28	10	—¼	600	8400	48	17	2¼	600	29000	168	13	8	—
5000	29	1	8	—	8500	49	8	10	—	30000	174	10	—	—
5100	29	13	3½	400	8600	50	—	5½	400	40000	232	13	4	—
5200	30	4	11	800	8700	50	12	1	800	50000	290	16	8	—
5300	30	16	6¾	200	8800	51	3	8¾	200	60000	349	—	—	—
5400	31	8	2¼	600	8900	51	15	4¼	600	70000	407	3	4	—
5500	31	19	10	—	9000	52	7	—	—	80000	465	6	8	—
5600	32	11	5½	400	9100	52	18	7½	400	90000	523	10	—	—
5700	33	3	1	800	9200	53	10	3	800	100000	581	13	4	—
5800	33	14	8¾	200	9300	54	1	10¾	200					
5900	34	6	4¼	600	9400	54	13	6¼	600					
6000	34	18	—	—	9500	55	5	2	—					
6100	35	9	7½	400	9600	55	16	9½	400					
6200	36	1	3	800	9700	56	8	5	800					
6300	36	12	10¾	200	9800	57	—	—¾	200					
6400	37	4	6¼	600	9900	57	11	8¼	600					
6500	37	16	2	—	10000	58	3	4	—					
6600	38	7	9½	400	11000	63	19	8	—					
6700	38	19	5	800	12000	69	16	—	—					
6800	39	11	—¾	200	13000	75	12	4	—					
6900	40	2	8¼	600	14000	81	8	8	—					
7000	40	14	4	—	15000	87	5	—	—					
7100	41	5	11½	400	16000	93	1	4	—					
7200	41	17	7	800	17000	98	17	8	—					
7300	42	9	2¾	200	18000	104	14	—	—					
7400	43	—	10¼	600	19000	110	10	4	—					
7500	43	12	6	—	20000	116	6	8	—					
7600	44	4	1½	400	21000	122	3	—	—					

A MONEY TABLE for STRONG BEER, in which the net Hereditary Revenue and additional Duties are calculated and proportioned to the Gallon of 217.6 Cubic Inches: Uſed in Dublin.

Gall.	Exciſe.			Gall.	Exciſe.			Gall.	Exciſe.			Gall.	Exciſe.		
	s.	d.			s.	d.			l.	s.	d.		l.	s.	d.
1	—	1¼	473	35	3	11¾	555	69		7	10¼	637	400	2	5	7¼ 200
2	—	2½	946	36	4	1¾	028	70		7	11¾	110	500	2	17	— 500
3	—	4	419	37	4	2½	501	71		8	1	583	600	3	8	4¾ 800
4	—	5¼	892	38	4	3¾	974	72		8	2½	056	700	3	19	9¼ 100
5	—	6¾	365	39	4	5¼	447	73		8	3¾	529	800	4	11	2½ 400
6	—	8	838	40	4	6½	920	74		8	5¼	002	900	5	2	7 700
7	—	9½	311	41	4	8	393	75		8	6½	475	1000	5	14	—¼ 000
8	—	10¾	784	42	4	9¼	866	76		8	7¾	948	1100	6	5	5 300
9	1	—¼	257	43	4	10¾	339	77		8	9¼	421	1200	6	16	9¼ 600
10	1	1½	730	44	5	—	812	78		8	10½	894	1300	7	8	2½ 900
11	1	3	203	45	5	1½	285	79		9	—	367	1400	7	19	7½ 200
12	1	4¼	676	46	5	2¾	758	80		9	1¼	840	1500	8	11	—¾ 500
13	1	5¾	149	47	5	4¼	231	81		9	2¾	313	1600	9	2	5 800
14	1	7	622	48	5	5½	704	82		9	4	786	1700	9	13	10 100
15	1	8½	095	49	5	7	177	83		9	5½	259	1800	10	5	2¼ 400
16	1	9¾	568	50	5	8¼	650	84		9	6¾	732	1900	10	16	7½ 700
17	1	11	041	51	5	9¾	123	85		9	8¼	205	2000	11	8	—¾ —
18	2	—¼	514	52	5	11	596	86		9	9½	678	3000	17	2	—¾ —
19	2	1½	987	53	6	—½	069	87		9	11	151	4000	22	16	1 —
20	2	3¾	460	54	6	1¾	542	88		10	—¼	624	5000	28	10	1¼ —
21	2	4½	933	55	6	3¼	015	89		10	1¾	097	6000	34	4	1½ —
22	2	6	406	56	6	4½	488	90		10	3	570	7000	39	18	1¾ —
23	2	7¼	879	57	6	5¾	961	91		10	4½	043	8000	45	12	2 —
24	2	8¾	352	58	6	7¼	434	92		10	5¾	516	9000	51	6	2¼ —
25	2	10	825	59	6	8½	907	93		10	7	989	10000	57	—	2½ —
26	2	11½	298	60	6	10	380	94		10	8½	462	20000	114	—	5½ —
27	3	—¾	771	61	6	11¼	853	95		10	9¾	935	30000	171	—	7½ —
28	3	2¼	244	62	7	—¾	326	96		10	11¼	408	40000	228	—	10 —
29	3	3½	717	63	7	2	799	97		11	—½	881	50000	285	1	—½ —
30	3	5	190	64	7	3½	272	98		11	2	354	60000	342	1	3 —
31	3	6¾	663	65	7	4¾	745	99		11	3¼	827	70000	399	1	5½ —
32	3	7¾	136	66	7	6¼	218	100		11	4¾	300	80000	456	1	8 —
33	3	9	609	67	7	7½	691	200	1	2	9½	600	90000	513	1	10½ —
34	3	10½	082	68	7	9	164	300	1	14	2¼	900	100000	570	2	1 —

A MONEY TABLE for SMALL BEER, in which the Net Hereditary Revenue and additional Duties are calculated and proportioned to the Gallon of 217.6 Cubic Inches: Uſed in Dublin.

Gall.	Exciſe. s.	d		Gall.	Exciſe. s.	d.		Gall.	Exciſe. s.	d.		Gall.	Exciſe. l.	s.	d.	
1	—	¼	025	35	—	8¾	875	69	1	5½	725	400	—	8	6½	—
2	—	½	050	36	—	9	900	70	1	5¾	750	500	—	10	8	500
3	—	¾	075	37	—	9¼	925	71	1	6	775	600	—	12	9¾	—
4	—	1	100	38	—	9½	950	72	1	6¼	800	700	—	14	11¼	500
5	—	1¼	125	39	—	9¾	975	73	1	6½	825	800	—	17	1	—
6	—	1½	150	40	—	10¼	—	74	1	6¾	850	900	—	19	2½	500
7	—	1¾	175	4	—	10½	025	75	1	7	875	1000	1	1	4¼	—
8	—	2	200	42	—	10¾	050	76	1	7¼	900	1100	1	3	5¾	500
9	—	2¼	225	43	—	11	075	77	1	7½	925	1200	1	5	7½	—
10	—	2½	250	44	—	11¼	100	78	1	7¾	950	1300	1	7	9	500
11	—	2¾	275	45	—	11½	125	79	1	8	97	1400	1	9	10¾	—
12	—	3	300	46	—	11¾	150	80	1	8½	—	1500	1	12	—	500
13	—	3¼	325	47	1	—	175	81	1	8¾	025	1600	1	14	2	—
14	—	3½	350	48	1	—	200	82	1	9	050	1700	1	16	3½	500
15	—	3¾	375	49	1	—	225	83	1	9¼	075	1800	1	18	5¼	—
16	—	4	400	50	1	—	250	84	1	9½	100	1900	2	—	6¾	500
17	—	4¼	425	51	1	1	275	85	1	9¾	125	2000	2	2	8½	—
18	—	4½	450	52	1	1¼	300	86	1	10	150	2100	2	4	10	500
19	—	4¾	475	53	1	1½	325	87	1	10¼	175	2200	2	6	11¾	—
20	—	5	500	54	1	1¾	350	88	1	10½	200	2300	2	9	1¼	500
21	—	5¼	525	55	1	2	375	89	1	10¾	225	2400	2	11	3	—
22	—	5½	550	56	1	2¼	400	90	1	11	250	2500	2	13	4½	500
23	—	5¾	575	57	1	2½	425	91	1	11¼	275	2600	2	15	6¼	—
24	—	6	600	58	1	2¾	450	92	1	11½	300	2700	2	17	7¾	500
25	—	6¼	625	59	1	3	475	93	1	11¾	325	2800	2	19	9½	—
26	—	6½	650	60	1	3¼	500	94	2	—	350	2900	3	1	11	500
27	—	6¾	675	61	1	3½	525	95	2	—	375	3000	3	4	—	—
28	—	7	700	62	1	3¾	550	96	2	—	400	3100	3	6	2¼	500
29	—	7¼	725	63	1	4	575	97	2	—	425	3200	3	8	4	—
30	—	7½	750	64	1	4¼	600	98	2	1	450	3300	3	10	5½	500
31	—	7¾	775	65	1	4½	625	99	2	1¼	475	3400	3	12	7¼	—
32	—	8	800	66	1	4¾	650	100	2	1½	500	3500	3	14	8¾	500
33	—	8¼	825	67	1	5	675	200	4	3¼	—	3600	3	16	10½	—
34	—	8½	850	68	1	5¼	700	300	6	4¾	500	3700	3	19	—	500

A MONEY TABLE for SMALL BEER, in which the Net Hereditary Revenue and additional Duties are calculated and proportioned to the Gallon of 217.6 Cubic Inches: Uſed in Dublin.

Gall.	Exciſe. l.	s.	d.		Gall.	Exciſe. l.	s.	d.		Gall.	Exciſe. l.	s.	d.	
3800	4	1	1¾	—	7200	7	13	9	—	70000	74	14	9½	—
3900	4	3	3¼	500	7300	7	15	10½	500	80000	85	8	4	—
4000	4	5	5	—	7400	7	18	—¼	—	90000	96	1	10½	—
4100	4	7	6½	500	7500	8	—	1¾	500	100000	106	15	5	—
4200	4	9	8¼	—	7600	8	2	3½	—					
4300	4	11	9¾	500	7700	8	4	5	500					
4400	4	13	11½	—	7800	8	6	6¾	—					
4500	4	16	1	500	7900	8	8	8¼	500					
4600	4	18	2¾	—	8000	8	10	10	—					
4700	5	—	4¼	500	8100	8	12	11½	500					
4800	5	2	6	—	8200	8	15	1¼	—					
4900	5	4	7½	500	8300	8	17	2¾	500					
5000	5	6	9¼	—	8400	8	19	4½	—					
5100	5	8	10¾	500	8500	9	1	6	500					
5200	5	11	—½	—	8600	9	3	7¾	—					
5300	5	13	2	500	8700	9	5	9¼	500					
5400	5	15	3¾	—	8800	9	7	11	—					
5500	5	17	5¼	500	8900	9	10	—½	500					
5600	5	19	7	—	9000	9	12	2¼	—					
5700	6	8	1½	500	9100	9	14	3¾	500					
5800	6	3	10¼	—	9200	9	16	5½	—					
5900	6	5	11¾	500	9300	9	18	7	500					
6000	6	8	1½	—	9400	10	—	8¾	—					
6100	6	10	3	500	9500	10	2	10¼	500					
6200	6	12	4¾	—	9600	10	5	—	—					
6300	6	14	6¼	500	9700	10	7	1½	500					
6400	6	16	8	—	9800	10	9	3¼	—					
6500	6	18	9½	500	9900	10	11	4¾	500					
6600	7	—	11¼	—	10000	10	13	6½	—					
6700	7	3	—¾	500	20000	21	7	1	—					
6800	7	5	2½	—	30000	32	—	7½	—					
6900	7	7	4	500	40000	42	14	2	—					
7000	7	9	5¾	—	50000	53	7	8½	—					
7100	7	11	7¼	500	60000	64	1	3	—					

A MONEY TABLE for ALE, in which the Net Hereditary Revenue and Additional Duties are calculated and proportioned to the Gallon of 217.6. Cubic Inches: Used in the Country.

Gall.	Excise. s.	d.	Parts of a Farthing.
1		1½	1
2		3	2
3		4½	3
4		6	4
5		7½	5
6		9	6
7		10½	7
8	1	0¼	1
9	1	1¾	2
10	1	3¼	3
11	1	4¾	4
12	1	6¼	5
13	1	7¾	6
14	1	9¼	7
15	1	11	
16	2	0½	1
17	2	2	2
18	2	3½	3
19	2	5	4
20	2	6½	5
21	2	8	6
22	2	9¾	7
23	2	11¼	1
24	3	¾	2
25	3	2¼	3
26	3	3¾	4
27	3	5¼	5
28	3	6¾	6
29	3	8½	7
30	3	10	1
31	3	11½	2
32	4	1	3
33	4	2½	4
34	4	4	5
35	4	5½	6
36	4	7	7
37	4	8¾	1
38	4	10¼	2
39	4	11¾	3
40	5	1¼	4
41	5	2¾	5
42	5	4¼	6
43	5	5¾	7
44	5	7½	1
45	5	9	2
46	5	10½	3
47	6		4
48	6	1½	5
49	6	3	6
50	6	4¾	7
51	6	6¼	1
52	6	7¾	2
53	6	9¼	3
54	6	10¾	4
55	7	¼	5
56	7	1¾	6
57	7	3¼	7
58	7	5	
59	7	6¼	2
60	7	8	3
61	7	9½	4
62	7	11	5
63	8	½	6
64	8	2	7
65	8	3¾	1
66	8	5¼	2
67	8	6¾	3
68	8	8¼	4
69	8	9¾	5
70	8	11¼	6
71	9	¾	7
72	9	2¼	1
73	9	4	2
74	9	5½	3
75	9	7	4
76	9	8½	5
77	9	10	6
78	9	11½	7
79	10	1¼	
80	10	2¾	1
81	10	4¼	2
82	10	5¾	3
83	10	7¼	4
84	10	8¾	5
85	10	10¼	6
86	10	11¾	7
87	11	1½	
88	11	3	1
89	11	4½	2
90	11	6	3
91		11	7½
92		11	9
93		11	10½
94		12	¼
95		12	1¾
96		12	3¼
97		12	4¾
98		12	6¼
99		12	7¾
100		12	9½
200	1	5	7
300	1	18	4½
400	2	11	2
500	3	3	11½
600	3	16	9
700	4	9	6½
800	5	2	4
900	5	15	1½
1000	6	7	11
2000	12	15	10
3000	19	3	9
4000	25	11	8
5000	31	19	7
6000	38	7	6
7000	44	15	5
8000	51	3	4
9000	57	11	3
10000	63	19	2
20000	127	18	4
30000	191	17	6

A MONEY TABLE for SMALL BEER, in which the Net Hereditary Revenue and Additional Duties are calculated and proportioned to the Gallon of 217.6. Cubic Inches: Used in the Country.

Gall.	Excise. s.	d.	Parts of a Farthing.
1	—	1/4	1
2	—	1/2	2
3	—	3/4	3
4	1		
5	1	1/4	1
6	1	1/2	2
7	2		
8	2	1/4	1
9	2	1/2	2
10	2	3/4	3
11	3		
12	3	1/4	1
13	3	3/4	3
14	4		
15	4	1/4	1
16	4	1/2	2
17	4	3/4	3
18	5		
19	5	1/4	1
20	5	1/2	2
21	6		
22	6	1/4	1
23	6	1/2	2
24	6	3/4	3
25	7		
26	7	1/4	1
27	7	3/4	3
28	8		
29	8	1/4	1
30	8	1/2	2
31	—	8 3/4	3
32	—	9	
33	—	9 1/4	1
34	—	9 3/4	3
35	10		
36	10	1/4	1
37	10	1/2	2
38	10	3/4	3
39	11		
40	11	1/2	2
41	11	3/4	3
42	1	—	
43	1	—	1/4 1
44	1	—	1/2 2
45	1	—	3/4 3
46	1	1	
47	1	1	1/2 2
48	1	1	3/4 3
49	1	2	
50	1	2	1/4 1
51	1	2	1/2 2
52	1	2	3/4 3
53	1	3	
54	1	3	1/2 2
55	1	3	3/4 3
56	1	4	
57	1	4	1/4 1
58	1	4	1/2 2
59	1	4	3/4 3
60	1	5	
61	1	5	1/2 2
62	1	5	3/4 3
63	1	6	
64	1	6	1/4 1
65	1	6	1/2 2
66	1	6	3/4 3
67	1	7	1/4 1
68	1	7	1/2 2
69	1	7	3/4 3
70	1	8	
71	1	8	1/4 1
72	1	8	1/2 2
73	1	8	3/4 3
74	1	9	1/4 1
75	1	9	1/2 2
76	1	9	3/4 3
77	1	10	
78	1	10	1/4 1
79	1	10	1/2 2
80	1	10	3/4 3
81	1	11	1/4 1
82	1	11	1/2 2
83	1	11	3/4 3
84	2	—	
85	2	—	1/4 1
86	2	—	1/2 2
87	2	1	
88	2	1	1/4 1
89	2	1	1/2 2
90	2	1	3/4 3

Gall.	Excise. l.	s.	d.	Parts of a Farthing.
91	—	2	2	3
92	—	2	2	1/4 1
93	—	2	2	3/4 3
94	—	2	3	
95	—	2	3	1/4 1
96	—	2	3	1/2 2
97	—	2	3	3/4 3
98	—	2	4	
99	—	2	4	1/4 1
100	—	2	4	3/4 3
200	—	4	9	1/2
300	—	7	2	1/4
400	—	9	7	
500	—	11	11	3/4
600	—	14	4	1/2
700	—	16	9	1/4
800	—	19	2	
900	1	1	6	3/4
1000	1	3	11	1/2
2000	2	7	11	
3000	3	11	2	1/2
4000	4	15	2	
5000	5	19	1	1/2

A new and correct MONEY TABLE for STRONG WATERS, at 2*d.* 8*d.* and 10*d.* *per* Gallon, for 1 to 2000 Gallons.

Gall.	2*d.*		8*d.*			10*d.*			Gall.	2*d.*		8*d.*			10*d.*		
	s.	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*		*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
1	—	2	—	—	8	—	—	10	31	5	2	1	—	8	1	5	10
2	—	4	—	1	4	—	1	8	32	5	4	1	1	4	1	6	8
3	—	6	—	2	—	—	2	6	33	5	6	1	2	—	1	7	6
4	—	8	—	2	8	—	3	4	34	5	8	1	2	8	1	8	4
5	—	10	—	3	4	—	4	2	35	5	10	1	3	4	1	9	2
6	1	—	—	4	—	—	5	—	36	6	—	1	4	—	1	10	—
7	1	2	—	4	8	—	5	10	37	6	2	1	4	8	1	10	10
8	1	4	—	5	4	—	6	8	38	6	4	1	5	4	1	11	8
9	1	6	—	6	—	—	7	6	39	6	6	1	6	—	1	12	6
10	1	8	—	6	8	—	8	4	40	6	8	1	6	8	1	13	4
11	1	10	—	7	4	—	9	2	41	6	10	1	7	4	1	14	2
12	2	—	—	8	—	—	10	—	42	7	—	1	8	—	1	15	—
13	2	2	—	8	8	—	10	10	43	7	2	1	8	8	1	15	10
14	2	4	—	9	4	—	11	8	44	7	4	1	9	4	1	16	8
15	2	6	—	10	—	—	12	6	45	7	6	1	10	—	1	17	6
16	2	8	—	10	8	—	13	4	46	7	8	1	10	8	1	18	4
17	2	10	—	11	4	—	14	2	47	7	10	1	11	4	1	19	2
18	3	—	—	12	—	—	15	—	48	8	—	1	12	—	2	—	—
19	3	2	—	12	8	—	15	10	49	8	2	1	12	8	2	—	10
20	3	4	—	13	4	—	16	8	50	8	4	1	13	4	2	1	8
21	3	6	—	14	—	—	17	6	51	8	6	1	14	—	2	2	6
22	3	8	—	14	8	—	18	4	52	8	8	1	14	8	2	3	4
23	3	10	—	15	4	—	19	2	53	8	10	1	15	4	2	4	2
24	4	—	—	16	—	1	—	—	54	9	—	1	16	—	2	5	—
25	4	2	—	16	8	1	—	10	55	9	2	1	16	8	2	5	10
26	4	4	—	17	4	1	1	8	56	9	4	1	17	4	2	6	8
27	4	6	—	18	—	1	2	6	57	9	6	1	18	—	2	7	6
28	4	8	—	18	8	1	3	4	58	9	8	1	18	8	2	8	4
29	4	10	—	19	4	1	4	2	59	9	10	1	19	4	2	9	2
30	5	—	1	—	—	1	5	—	60	10	—	2	—	—	2	10	—

A new and correct MONEY TABLE for STRONG WATERS, at 2d. 8d. and 10d. per Gallon, for 1 to 20000 Gallons.

Gall.	2d.		8d.			10d.			Gall.	2d.			8d.			10d.		
	s.	d.	l.	s.	d.	l.	s.	d.		l.	s.	d.	l.	s.	d.	l.	s.	d.
61	10	2	2	—	8	2	10	10	91	—	15	2	3	—	8	3	15	10
62	10	4	2	1	4	2	11	8	92	—	15	4	3	1	4	3	16	8
63	10	6	2	2	—	2	12	6	93	—	15	6	3	2	—	3	17	6
64	10	8	2	2	8	2	13	4	94	—	15	8	3	2	8	3	18	4
65	10	10	2	3	4	2	14	2	95	—	15	10	3	3	4	3	19	2
66	11	—	2	4	—	2	15	—	96	—	16	—	3	4	—	4	—	—
67	11	2	2	4	8	2	15	10	97	—	16	2	3	4	8	4	—	10
68	11	4	2	5	4	2	16	8	98	—	16	4	3	5	4	4	1	8
69	11	6	2	6	—	2	17	6	99	—	16	6	3	6	—	4	2	6
70	11	8	2	6	8	2	18	4	100	—	16	8	3	6	8	4	3	4
71	11	10	2	7	4	2	19	2	200	1	13	4	6	13	4	8	6	8
72	12	—	2	8	—	3	—	—	300	2	10	—	10	—	—	12	10	—
73	11	2	2	8	8	3	—	10	400	3	6	8	13	6	8	16	13	4
74	12	4	2	9	4	3	1	8	500	4	3	4	16	13	4	20	16	8
75	12	6	2	10	—	3	2	6	600	5	—	—	20	—	—	25	—	—
76	12	8	2	10	8	3	3	4	700	5	16	8	23	6	8	29	3	4
77	12	10	2	11	4	3	4	2	800	6	13	4	26	13	4	33	6	8
78	13	—	2	12	—	3	5	—	900	7	10	—	30	—	—	37	10	—
79	13	2	2	12	8	3	5	10	1000	8	6	8	33	6	8	41	13	4
80	13	4	2	13	4	3	6	8	2000	16	13	4	66	13	4	83	6	8
81	13	6	2	14	—	3	7	6	3000	25	—	—	100	—	—	125	—	—
82	13	8	2	14	8	3	8	4	4000	33	6	8	133	6	8	166	13	4
83	13	10	2	15	4	3	9	2	5000	41	13	4	166	13	4	208	6	8
84	14	—	2	16	—	3	10	—	6000	50	—	—	200	—	—	250	—	—
85	14	2	2	16	8	3	10	10	7000	58	6	8	233	6	8	291	13	4
86	14	4	2	17	4	3	11	8	8000	66	13	4	266	13	4	333	6	8
87	14	6	2	18	—	3	12	6	9000	75	—	—	300	—	—	375	—	—
88	14	8	2	18	8	3	13	4	10000	83	6	8	333	6	8	416	13	4
89	14	10	2	19	4	3	14	2	20000	166	13	4	666	13	4	833	6	8
90	15	—	3	—	—	3	15	—										

Directions for the ready finding all the Acts in EDGAR, &c. which correspond with the business of an EXCISE-OFFICER.

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ANY Seaman or other Perſon, either aiding or being preſent at the delivering or receiving of any Goods from any Ship, *&c.* and ſhall not within a Month after diſcloſe the ſame, he ſhall, for every ſuch offence, forfeit ten Pounds *ſterl.* to be levied by diſtreſs, or in default thereof, be committed to the next Houſe of Correction. *Vide* Edgar, 133

If any Perſon (not being a principal) but an Abettor, ſhall diſcover ſuch Frauds, he ſhall not only be acquitted of the Penalty in relation to himſelf, but ſhall alſo receive one moiety of the Fines. 172

Any Perſon who ſhall harbour, or permit to be harboured, ſell, or expoſe to ſale, or buy any Exciſeable Goods (knowing them to be run) ſhall, beſide the forfeiture of the Goods, forfeit alſo treble the Value of them. *Ann. Georg Reg.* 12.

Every retailing Brewer, who ſhall brew or make any Guile of Beer or Ale, ſhall declare to the proper Guager, how much Strong, and how much Small he intends to make before he removes it; or upon the Brewer, or his reſpective Servant's refuſal to make ſuch declaration, the Guager is to charge the whole ſtrong, and the Brewer ſhall not only pay the Duty accordingly, but alſo forfeit twenty Shillings for each Barrel contained in the ſaid Brewing. 4 *Georgii* I. *Cap.* 2. *Sect.* 7.—and *Edgar* 288

If a Brewer, or his Servants, ſhall mix or make any increaſe whatſoever in Beer or Ale, (nay even from what remained of a former Brewing, unleſs in the ſight of the Guager) ſuch Brewer ſhall forfeit for every Barrel the Sum of five Pounds, and the Servant

aſſiſting

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affiſting, the ſum of twenty Shillings for every Barrel, or in default ſuffer three months impriſonment. 288

Note, Arms and Ammunition are exempted from payment of Exciſe. *Vide Exciſe-Act, Sect. 7th.*—and *Edgar* 127

If any common Brewer ſhall refuſe the Guager to enter into his Houſe, Brew-Houſe or any other Houſe or place belonging to him, and to ſee his Coppers and other Veſſels, or ſhall deny to ſhew the Beer or Ale made by him, he ſhall forfeit for every ſuch denial the ſum of fifty Pounds, and be alſo preſently forbidden by the Officer, to carry or deliver any Beer or Ale; which if he ſhall nevertheleſs do, he ſhall forfeit double the value of all ſuch Beer or Ale. *Vide Exciſe-Act, Sect* 38.—and *Edgar*, 148

Every Guager has a right to taſte drink in Innkeepers Cellars, and upon the Inn-keeper's refuſing, he is to forfeit five Pounds. 4 *Georg. Reg. Sect. 9th*—and *Edgar*. 289

All and every the Brewing-Veſſels and Utenſils uſed in any Brew-houſe, into whoſe hands the ſame ſhall come, and by what conveyance or title ſoever the ſame ſhall be claimed, ſhall be liable to all Arrears and Penalties incurred by the perſon ſo uſing the ſaid Brew-houſe. 1 *Georgii* II. *Regis, Cap.* 1 *Sect.* 5.

Obſerve, No Diſtiller is to carry out, or deliver any Aqua Vitæ, or Spirits, to any cuſtomer, by a Caſk or Gallon (without Notice given to the proper Officer) unleſs at lawful Hours, *viz.* from the *25th of March*, to the *29th of September*, between the Hours of three in the Morning, and nine in the Evening; and from the *29th of September* to the *25th of March*, between the Hours of five in the Morning, and eight in the Evening; or for every ſuch offence forfeit ten Pounds. And all and every the Stills, Worms, Still-heads, Tubs, and other Utenſils, are liable to all Arrears and Penalties due by any Perſon for Spirits diſtilled in the ſaid

Houſe,

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House, let them be found with whomsoever, or under what colour soever. 1 *Georg. Reg. Cap.* 1. *Sect.* 5.

If any Sheriff, or his deputy, shall make replevin of any distress, taken for Excise or Penalties, every such Sheriff shall forfeit double the sum for which the Distress was taken. *Excise-Act, Sect.* 63.—and *Edgar,* 166

At Fairs the Persons shall pay their Excise before they Tap, and upon their refusing, the Officer may seize and detain the said Beer or Ale, until paid the Duty. *Excise-Act, Sect.* 40.—and *Edgar,* 150

A Collector is to receive yearly the Fees here mentioned, and no more, upon pain of forfeiting ten Pounds *sterl.* and lose his Employ, *viz.* One Shilling for Ale; the like for X-Waters; and Two Shillings for Wine Licences. *Vide* 14, 15, 17 and 18 *Carol.* II. *Cap.* 18, 19. *Sect.* the 3d,—and *Edgar,* 241

For Quit-Rent the Collector may demand the Fees hereafter mentioned, and no more, *viz. Vide* 9 *Guliel.* III. *Cap.* 31. *Sect.* 4.

	l.	*s.*	*d.*
For every acquittance they shall give for any Sum above five Shillings, and not exceeding twenty Shillings	—	—	6
For every Sum above twenty Shillings, and not exceeding five Pounds. —	—	1	—
For every Sum above five Pounds and not exceeding fifteen Pounds —	—	1	6
And for every Sum above fifteen Pounds	—	2	—

And in no case to receive any more for any one acquittance than two Shillings.

For entering the acquittance, and signing the Book, by the Persons paying	—	—	2

For

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For want of Diſtreſs to ſatisfy any Fine or Penalty, the Perſon to be committed to the next Goal or Houſe of Correction, where the Gaoler is to receive them, and ſet them to work (by which they are to be maintained,) and if he ſuffer any ſuch Perſon to eſcape, he is to forfeit double the Sum by Diſtreſs. *Vide Exciſe-Act, Sect.* 63 —and *Edgar.* 166

Perſons guilty of a wilful Perjury at an Exciſe-Office, and thereof convicted at an Aſſizes or Quarter-Seſſions, the Perſon ſo offending, is to be put in the Pillory, by a *Stat.* 28 *Elizab.* Vide *Edgar.* 170

Any Perſon who ſhall preſume to ſell Ale without Licence, ſhall for every time he ſo offends, forfeit five Pounds. 14 and 15 *Carol.* II. *Cap.* 18.—and *Edgar* 228

If any Perſon concerned in the Exciſe, ſhall conceal any Perſon's Licence, he ſhall for every offence forfeit ten Pounds. ibid.

An Officer, upon denial of entrance, may with the Conſtable break open doors in the day-time. 1 *Georg.* II. *Cap.* 1. *Sect.* 4.

If any Perſon ſhall aſſault or reſcue from an Officer in ſeizing any exciſeable Goods, he ſhall for the firſt offence forfeit one hundred Pounds; or on failure of Payment, ſuffer Twelve Months Impriſonment; and for the ſecond offence, ſhall be tranſported to ſome of his Majeſty's plantations in *America*; there to continue for ſeven years. 12 *Geo.* I. *Sect.* 15.

Compounders to ſell Beer and Ale in their Dwelling-houſes only, by virtue of their agreement, and if he ſhall ſell Beer or Ale by the Barrel, *&c.* to any Houſe-keeper, Victualler, *&c.* out of his Dwelling-houſe, the perſon ſo ſelling, and he who buys, ſhall each forfeit the Sum of forty Shillings, to be levied by diſtreſs. *Vide Edgar,* 151

Barter deemed ſale in the act of Exciſe. *Vide Edgar* 139

Porters,

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Porters, Carmen, &c. refuſing to carry goods to the Exciſe Office, or other place of ſecurity, which goods have been ſeized by an Officer; ſuch Porter, &c. ſhall forfeit ten Pounds, to be levied by diſtreſs, provided he be rendered reaſonable allowance for his trouble. *Vide Edgar,* 159

Upon information, witneſſes or parties in any diſtrict may be ſummoned, as if reſident where ſuch information was exhibited; and ſuch perſons refuſing to appear; or appearing, refuſing to ſwear; or ſwearing, refuſing to give direct anſwers, ſhall forfeit ten Pounds, to be levied by diſtreſs; and for want of diſtreſs, to be committed to the next Gaol, or Houſe of Correction. *Ann. quint. Georg.* 2. *Regis*—and *Edgar* 165

If any Perſon believing himſelf aggrieved by any judgment of a Sub-commiſſioner, deſigns to appeal, ſuch appeal muſt be made within two calender months after ſuch judgment; or it ſhall not be received. *Ann.* 12 *Geo.* I. *Cap.* 1. *Sect* 7.

Brewers diſtrained by the judgment of a Sub-commiſſioner (in caſes of concealments) muſt proſecute his or their complaint before a Juſtice of the Peace, within the time of fourteen days, otherwiſe the Officer may proceed to the ſale of the Goods and Chattles ſo diſtrained. *Excise Act, Sect* 44.—and *Edgar,* 152

No Perſon whatſoever ſhall preſume to keep a common Ale-houſe, or Tippling-houſe, or uſe ſelling of Beer or Ale without licence; upon pain that every Perſon ſo offending, ſhall for every time forfeit the ſum of five Pounds. 14 and 15 *Carol.* II. *Cap.* 18. and *Edgar,* 219

Licenced Perſons muſt be thoſe of good behaviour, able to entertain travellers, their dwelling muſt be in convenient places, as Market-towns, in Villages, or on Roads. 14 and 15 *Carol.* II. *Cap.* 18—and *Edgar* 217

Every Perſon ſo licenced, is to have a ſign or buſh at his door, to inform travellers and ſtrangers. *Vide Car. ibid.*—and *Edgar,* 222

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No Perſon (unleſs he be licenced) ſhall ſell by retail, *viz.* by the Pint, Quart, Pottle or Gallon, or by any greater or leſſer retailing meaſure, any kind of Aqua Vitæ, or Spirits, to be drank or ſpent within his manſion-houſe, or any other place in his tenure or occupation, by any means whatſoever, upon pain of forfeiting for every ſuch offence the ſum of five Pounds. 17 and 18 *Carol.* II. *Cap.* 15—and *Edgar*, 237

Every Sub-commiſſioner (if required by the Defendant) is to take his Oath, adminiſtered by the Clerk of the Seizures, that he is diſintereſted and neither to gain or loſe by that Information depending before him; and upon refuſing ſuch an Oath, he is then diſqualified to hear the matter. *Ann. quint. Georg.* II. *Reg.*

All Wines in Hogſheads, Brandy, and other foreign Spirits, in veſſels containing more than four Gallons; Tobacco above the weight of four Pounds; Silk in whole Pieces; Tea exceeding the weight of two Pounds, that ſhall be carried into the land parts of this Kingdom, ſhall be liable to be ſeized by any Officer of his Majeſty's Revenue, and deemed forfeited, unleſs the Carrier ſhall actually produce a Permit from the proper Office, or make Oath of the loſs of ſuch Permit. *Ann. quint. Geog.* II. *Reg.*

Fees to be taken by Officers for Permits; for any Permit of any quantity of Tobacco under a Hundred Pound Weight, or other Goods under the value of five Pounds, *one Penny*, and no more. And for every Permit for any quantity of Tobacco of one Hundred Weight and upwards, and other goods of the value of five Pounds and upwards, *three Pence*, and no more. *Ibid.*

An Officer may diſtrain for Ale, Wine, or X Water licence (by day with a Conſtable.) *Ibid.*

No Perſon is to have a Still fixed, farther from a Market-town than the ſpace of two miles, under pain

of

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of forfeiting the Sum of forty Pounds. Nor ſhall any Perſon keep a fixed Still for his private uſe, which ſhall contain more than twelve Gallons; upon pain of being deemed a common Diſtiller, and liable to the Duties arising from ſuch Liquor. *Ibid.*

No Perſon deemed a Retailer, but ſuch as ſells under a Gallon of Spirits. *Ibid.*

Obſerve that all Perſons convicted for private ſelling, are for the firſt offence to forfeit twenty Shillings; and for the ſecond forty; but for the third he ſhall not only forfeit three Pounds, *Sterl.* but may be ſent to Gaol, till he enters into Bond, with good Security, in the Penal Sum of twenty Pounds *Sterl.* that he will not ſell at any time afterwards. *See Edgar.* - - - 146

All Perſons convicted of private ſelling, are in the Law deemed Retailers, and conſequently are not only liable to the Fine, but alſo by the Hereditary Act, made the 14 and 15 of *Charles* the 2*d*, are to be charged with Licence and Exciſe for all the Liquor found with them, till the *Eaſter* following. *See Edgar*, Page 125, and line 22*d*, where he ſays (any Perſon who ſhall tap or ſell Beer or Ale publicly or privately) which words make this Act applicable to private as well as public Brewers.

Officers to have twenty Days Notice of Trial in Actions brought againſt them. See the Act made the 7th Year of the Reign of King George II, entitled, *An Act for the more effectual preventing Frauds and Abuſes in his Majeſty's Cuſtoms and Exciſe.*

Copies of the Entries of Officers Commissions to be allowed as Evidence in all Suits, Indictments, and Informations. *Ibid.*

Note. That the ſituation of Backs and Coolers are not to be altered, under the Penalty of five Pounds. *Ibid.*

Note. That the ſeveral Duties and Forfeitures ariſing by Licences for ſelling of Ale, Wine, and X Waters,

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are to be collected and paid as by the Act of Excise. *Vide* an Act made in the 7th Year of King George the II. *viz.* (an Act for continuing and amending) an Act for preventing several Frauds and Abuses committed in his Majesty's Customs and Excise, by which it is plain, that the Commissioners and Sub-commissioners have full power to summons, hear, judge, and fine in the above Cases, as they have in the Excise Act, to which they are referred; which Act of Excise is to continue as fully and effectually as if expressed in the body of this Act. See an Act made in the same Year, entitled, *An Act for granting his Majesty a further additional Duty on Wine, &c.*